Damages Calculation for Federal Lands: Coeur d'Alene Basin Natural Resource Damage Assessment

Prepared for:

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United States Department of Agriculture, Forest Service
Coeur d'Alene Tribe

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Contents

Figures

SC10483

USEXRPT000275

Tables

I. Introduction to Report and Authors

I.1 Purpose

This expert report describes natural resource damage calculations for injured federal lands in the floodplains of the Coeur d'Alene River basin.

I.2 Information Considered

In developing our opinions, we have relied on information developed by numerous investigators, including federal and state resource agencies, contractors to federal and state agencies, and academic researchers. The information developed by these various investigators (for example, digital elevation models and maps of sediment concentrations, floodplain areas, vegetation classifications, and land ownership) is of the type that can be reasonable relied on for the analyses in this report. The analyses in this report have been conducted using accepted scientific and engineering methodology.

A full list of the data considered is presented in Chapter 7, Literature Cited, of this report.

I.3 Authors

This report contains the opinions and conclusions of Dr. Katherine LeJeune, Mr. David Chapman, and Mr. Greg Koonce.

Dr. Katherine LeJeune is an ecosystem ecologist and a principal at Stratus Consulting Inc. in Boulder, Colorado. Her resume is provided in Appendix C. Dr. LeJeune has provided testimony at deposition or trial within the past four years in the following matter:

- United States v. ASARCO Inc. et al., No. CV 96-0122-N-EJL.

Dr. LeJeune is responsible for data and opinions related to riparian resources injury quantification, ecological recovery trajectories, service losses and gains, and scientific principles of restoration ecology contained in Chapters 1, 2, 3, 4, and 6 and Appendix A.

Mr. David Chapman is an environmental and resource economist and a managing economist at Stratus Consulting Inc. in Boulder, Colorado. His resume is provided in Appendix C.

Mr. Chapman is responsible for report sections related to cost of acquisition of land and conservation easements, habitat equivalency analysis, and damage determination. These include Sections 1.3.2, 2.2, 2.3, 5.1, and 5.5, Chapter 6, and Appendix B.

Mr. Greg Koonce is a fisheries biologist and principal at Inter-fluve, Inc. in Portland, Oregon. His resume is provided in Appendix C. Mr. Koonce has provided testimony at deposition or trial within the past four years in the following matter:

- Peace River/Manasota Regional Water Supply Authority v. IMC Phosphates Company and the Florida Department of Environmental Protection. Nos. 03-0791, 03-0792, 03-0804, 03-0805, 03-1610, 03-3287, 03-3288, 03-3289.

Mr. Koonce is responsible for sections on ecological restoration conceptual design and project implementation, and costing, as contained in Sections 4.2.2, 4.3.1, 4.3.3, 4.3.4, 5.2, 5.3, 5.4, and 5.5.

I.4 Compensation Received

Dr. LeJeune and Mr. Chapman are employees of Stratus Consulting Inc. Stratus Consulting has been compensated at the time and materials hourly rate of $145 for Dr. LeJeune's work, and $160 for Mr. Chapman's work. Total compensation received by Stratus Consulting for the preparation of this expert report is approximately $200,000.

Mr. Koonce is an employee of Inter-fluve, Inc. Inter-fluve has been compensated for Mr. Koonce's work at the time and materials hourly rate of $180. Total compensation received by Inter-fluve for the preparation of this expert report is approximately $10,000.

1. Introduction

The United States and the Coeur d'Alene Tribe (collectively, the Trustees) have undertaken a natural resource damage assessment (NRDA) to assess damages resulting from releases of hazardous substances from mining and mineral processing operations in the Coeur d'Alene River basin, Idaho. Section 107 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) [42 U.S.C. § 9607], Section 311 of the Clean Water Act (CWA) [33 U.S.C. § 1321], and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 C.F.R. Part 300] provide authority to the Trustees to seek such damages.

Lands administered by federal agencies in the Coeur d'Alene basin have been injured by the release of hazardous substances from mining and mineral processing operations. This expert report is one of several reports that calculate damages for the injuries to natural resources in the Coeur d'Alene basin. As defined in the U.S. Department of the Interior's (DOI) regulations for conducting NRDAs [43 CFR Part 11],[1] damages are "the amount of money sought by the natural resource trustee as compensation for injury, destruction, or loss of natural resources." This report presents the calculation of damages for injuries to federal lands where damages are measured as the costs of the replacement of the injured natural resources [43 CFR § 11.82(b)(ii)]. As described in Section 1.3 of this report, these replacement costs are only one component of total damages; other expert reports present other damage calculations, and a summary report (Lipton et al., 2004a) describes all of the damages.

This report follows the Court's decisions regarding natural resource injury and liability resulting from hazardous substance releases from mining and mineral processing in the Coeur d'Alene River basin (U.S. District Court, 2003). It also follows the September 2000 "Report of Injury Assessment and Injury Determination: Coeur d'Alene Basin Natural Resource Damage Assessment" prepared for the Trustees by Stratus Consulting (Stratus Consulting, 2000) and other materials presented in the Phase 1 trial (Case No. CV91-0342-N-EJL, CV96-0122-N-EJL, 2001; U.S. District Court, District of Idaho).

1. The DOI has promulgated regulations for conducting NRDAs [43 CFR Part 11]. The Trustees have relied to the extent appropriate on these regulations in assessing the natural resource damages. The application of these regulations is not mandatory, and the Trustees have the option of diverging from them as appropriate.

This report is organized as follows:

- The remainder of Chapter 1 describes the injuries to federal lands for which damages are calculated in this report (Section 1.1), describes the scope of damages addressed in this report (Section 1.2), and describes the overall approach used to calculate damages for federal lands (Section 1.3).
- Chapter 2 describes the approach used to calculate damages for injured upper basin federal lands, which is to calculate damages as the cost of conducting restoration actions that replace the habitat services[2] lost because of the injuries.
- Chapter 3 presents the quantification of injuries to upper basin federal lands, both in terms of acres injured and temporal extent of injury.
- Chapter 4 describes the project alternatives considered that can replace the riparian habitat services lost because of injuries.
- Chapter 5 presents the per unit costs of conducting each of the restoration project alternatives.
- Chapter 6 presents the calculation of damages as the cost of conducting habitat restoration projects that replace the lost habitat services.
- Appendix A contains photographs of the injured federal lands in the upper basin.
- Appendix B contains detailed information supporting cost estimates of land and conservation easements.
- Appendix C contains resumes of the authors (K. LeJeune, D. Chapman, and G. Koonce).

1.1 Summary of Injury to Federal Lands

Lands administered by the federal government in the Coeur d'Alene basin have been injured by releases of hazardous substances from mining and mineral processing operations in the basin. In Phase 1 of the trial, the Court concluded the following (U.S. District Court, 2003):

2. Services are defined by DOI NRDA regulations as "the physical and biological functions performed by the resource including the human uses of those functions. These services are the result of the physical, chemical, or biological quality of the resource" [43 CFR § 11.14(nn)].

- "The releases [of hazardous substances] that occurred in the Basin and continue to occur, have caused injury to natural resources in the Basin" [§ II.D.1, p. 12].
- "Leaching of hazardous materials from mining waste, including mixed tailings and alluvium in the beds and banks of the rivers and streams of the Basin, occurs whenever mining waste is exposed to elements and this creates a cycle of continuing releases of hazardous substances" [§ II.D.2, p. 12].
- "The co-mingled mining waste is the primary cause of the damage to natural resources in the Basin" [§ II.D.4, p. 12].
- "*Soils and Sediments*. Soil analysis and the lack of vegetation in certain parts of the Basin support this Court's finding that soils and sediments have been injured by the releases of hazardous substances by Defendants" [§ III.J, p. 41].
- "*Riparian Resources*. Impacts to riparian resources associated with mining include barren areas caused by physical and/or chemical conditions that are not conducive to plant growth in the South Fork area of the Basin. This impact cannot be completely explained by urbanization, forest fires or other factors besides mining waste" [§ III.J, p. 41].
- "Sediment concentrations of metals throughout the Basin exceed the applicable baseline" [§ II.D.7, p. 13].
- "The Court finds Plaintiffs have carried their burden and established that some injury has occurred in both macroinvertebrates and phytoplankton" [§ III.J, p. 42].

The Trustees' injury assessment report and the expert reports and testimony of several government witnesses in Phase 1 of the trial present details on the injury to riparian soil, sediment, and vegetation, and the services provided by these riparian resources, resulting from hazardous substance releases in the basin. In summary (Stratus Consulting, 2000):

- Concentrations of hazardous substances in exposed floodplain soils of Canyon Creek, Ninemile Creek, the South Fork Coeur d'Alene River, and the lower Coeur d'Alene River basin are substantially elevated relative to reference areas. Floodplains are contaminated with mining-related hazardous substances from the direct discharge of mining wastes and through the deposition of tailings or contaminated sediments in natural hydrological processes, such as high flow events.
- The elevated concentrations of hazardous substances in these floodplain areas are toxic to plants, and riparian vegetation is absent or greatly reduced in many riparian areas as a direct result of the toxicity of the hazardous substances.

- As a result of the lack of or greatly reduced cover of riparian vegetation, the ecological function of these riparian areas is severely diminished.

In addition, sediments of the lower basin floodplain contain concentrations of lead and other hazardous substances in concentrations sufficient to cause injury to tundra swans and other biota (Beyer, 1999; Stratus Consulting, 2000).

1.2 Scope of Federal Lands Damage Calculation

The damage calculations presented in this report are for federal lands in the Coeur d'Alene basin where resources have been injured by the releases of hazardous substances from mining and mineral processing operations. Injured lands administered by the DOI Bureau of Land Management (BLM) and the U.S. Department of Agriculture (USDA) Forest Service include lands in the floodplains of Canyon Creek, Ninemile Creek, South Fork Coeur d'Alene River, and the mainstem Coeur d'Alene River downstream of mining operations.[3] In addition to natural resource trusteeship for the lands, the federal agencies also have a responsibility to manage the lands and their resources to protect scientific, scenic, historical, ecological, and environmental values, to provide wildlife habitats and outdoor recreation for humans, and for extractive uses [Federal Land Policy and Management Act of 1976, 43 U.S.C. §§ 1701-1736, 1737-1782].

1.3 Overall Approach to Calculating Natural Resource Damages

Natural resource damages for federal lands are calculated according to the NRDA regulations promulgated by the Department of Interior at 43 CFR Part 11 (hereafter referred to as the DOI regulations). The DOI regulations state that [43 CFR §11.80(b)]:

> the measure of damages is the cost of restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured natural resources and the services those resources provide. Damages may also include, at the discretion of the authorized official, the compensable value of all or a portion of the services lost to the public for the time period from the discharge or release until the attainment of the restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the resources and their services to baseline.[4]

3. Only injured federal lands downstream of mining facilities owned or operated by Hecla or Asarco were included in the quantification of damages.

4. Baseline is "the condition or conditions that would have existed at the assessment area had the . . . release of the hazardous substance under investigation not occurred" [43 CFR § 11.14(e)].

Restoration or rehabilitation actions "are those actions undertaken to return injured resources to their baseline condition" [43 CFR §11.82(b)(1)(i)]. Replacement or acquisition refers to the "substitution for injured resources with resources that provide the same or substantially similar services" [43 CFR §11.82(b)(1)(ii)].

1.3.1 Relationship of NRDA restoration to EPA response actions

NRDA restoration actions are distinct from the U.S. Environmental Protection Agency's (EPA's) response actions in the Coeur d'Alene River basin. EPA conducts response actions to address hazardous substance releases. NRDA restoration actions restore injured resources and their services to baseline conditions, which are the conditions the resources and services would have been in had the hazardous substance releases not occurred [43 CFR §11.82(b)(1)(i)]. NRDA restoration must take into account any EPA response actions and evaluate whether the response actions are sufficient to restore injured resources and services to baseline. If the response actions are not sufficient to do so, then the cost of the additional NRDA restoration actions necessary to restore injured resources and services to baseline is a measure of damages [43 CFR §11.80(b)].

The EPA issued Records of Decision (RODs) for operable units (OUs) 1 and 2 of the Bunker Hill Superfund Site (the Box) in 1991 and 1992 (U.S. EPA, 1991, 1992) and an interim ROD in September 2002 for OU3 of the site (the Coeur d'Alene basin) (U.S. EPA, 2002).[5] In addition, EPA has conducted other CERCLA response actions in the basin that are not addressed in the RODs. The EPA remedy for OU3 addresses human exposure to contaminated soils in communities and residential areas, and selected ongoing source areas and areas of ecological exposure along the creeks and rivers of the basin. Specifically, the OU3 ROD includes the following remedial actions (U.S. EPA, 2002):

- Partial excavation of selected residential soils with high lead concentrations and other actions to reduce human exposure to lead in residential areas.
- In the upper basin, excavation and disposal, containment, bioengineering, and surface water treatment actions to reduce dissolved metals in rivers and streams. Waste dumps and stream banks that are major sources of particulate metals will be stabilized to reduce erosion.
- In the lower basin, capping and excavation of contaminated soils in selected, high-priority floodplain areas (areas with high use by waterfowl, high levels of lead in sediments, ready access, and relatively low potential for recontamination during flood events).

5. The two RODs for the Box address the "Populated Areas" (also called Operable Unit 1 or OU1) and the "Unpopulated Areas" (also called OU2). The Coeur d'Alene River basin is OU3.

- Also in the lower basin, selected excavation of contaminated bank sediment and bank stabilization for areas that are highly susceptible to erosion.

The OU3 ROD states that the selected remedial action is "not intended to fully address contamination within the Basin"(U.S. EPA, 2002). For example, the OU3 ROD establishes a benchmark cleanup criterion for the soil and sediment in the lower basin of 530 mg/kg lead, but the selected remedial action will achieve this cleanup criterion in only a small portion of the approximately 18,300 acres of land in the lower basin with lead concentrations greater than 530 mg/kg (U.S. EPA, 2002). Thus, the selected EPA remedy will not restore injured resources of the Coeur d'Alene basin to baseline, and additional NRDA restoration actions are required to do so.

Included in the areas specified for cleanup in the OU3 ROD are some parcels of federal land administered either by the DOI BLM or the USDA Forest Service. The cleanup of the federal lands identified in the OU3 ROD will be conducted by the federal land agencies in coordination with the rest of the cleanup specified in the ROD. The federal land agencies may seek to recover their response costs from the responsible parties at a later date. However, the response costs that have been and will be incurred by the DOI BLM or the USDA Forest Service are wholly separate from NRDA damages, and such costs are not included in any of the damage calculations presented in this report.

1.3.2 The cost of NRDA restoration actions as the measure of damages

Injured resources and their services can be restored to baseline conditions through conducting contaminant cleanup actions supplemental to the EPA response actions, including those specified in the OU3 ROD. The cost to implement basin cleanup that supplements EPA's actions and restores resources to baseline conditions is therefore a measure of natural resource damages [43 CFR §11.80(b)].

A separate expert report prepared by Ridolfi and Falter (2004) calculates damages as the cost to conduct either a comprehensive or a staged alternative to performing contaminant cleanup actions in addition to those in the OU3 ROD to restore injured resources to baseline. In addition, the report provides cost estimates for cleanup of federal lands not addressed by the OU3 ROD, and for a management alternative that would be necessary if full restoration is not performed.

The following two sections describe how natural resource damages are calculated specifically for federal lands. Descriptions are provided separately for federal lands in the lower and upper basins (defined as the areas downstream and upstream, respectively, of the confluence of the South Fork and North Fork Coeur d'Alene rivers).

Federal lands in the lower Coeur d'Alene basin

The federal government administers 1,114 acres of mine-waste-contaminated land in the lower Coeur d'Alene basin floodplain[6] (Table 1.1). Approximately 191 acres of the total are identified for cleanup as part of the EPA OU3 ROD. The cleanup of these federal lands will be conducted by the federal land agencies in coordination with the rest of the cleanup specified in the ROD. The federal land agencies may seek to recover their response costs from the responsible parties at a later date. These response costs are not included in any of the damage calculations presented in this report.

Table 1.1 Damage calculation method for contaminated federal lands in the lower basin[a]

Land description		Number of acres[b]	How damages calculated (where reported)
Identified for cleanup in OU3 ROD[c]		191	For the portion that is swan feeding habitat, damages addressed in the damage calculation for swans (Kern, 2004; Trost, 2004) For the remainder, no damages calculated
Not identified for cleanup in OU3 ROD	Swan feeding habitat	374	Cost to conduct cleanup (Ridolfi and Falter, 2004)
	Not swan feeding habitat	549	No separate damages calculated (but included in cost of NRDA basin-wide cleanup in Ridolfi and Falter, 2004)
Total		1,114	

a. Only federal lands within the lower basin floodplain with surficial lead concentrations of greater than or equal to 530 mg/kg are included.
b. U.S. Bureau of Land Management (2002), Ridolfi and Falter (2004).
c. The cleanup of federal lands identified in the OU3 ROD will be conducted by the federal land agencies and may be the subject of future cost recovery actions. These costs are not included in any of the damage calculations.

The remaining 923 acres of contaminated lower basin federal land are not being addressed by the EPA OU3 ROD (Ridolfi and Falter, 2004). Of the 923 acres, 374 are palustrine wetlands used as feeding habitat by tundra swans (Ridolfi and Falter, 2004; Trost, 2004). The estimated present value cost to clean the 374 acres of swan feeding habitat by excavating mine waste and contaminated material and constructing levees and dikes to prevent recontamination is $14.4 million, in 2004 dollars (Table G.5, Appendix G, Ridolfi and Falter, 2004).

6. Defined as lands with lead concentrations exceeding 530 mg/kg, which is EPA's benchmark cleanup criterion for soil and sediment in the OU3 ROD (U.S. EPA, 2002).

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Of the 549 acres that are not swan feeding habitat and are not addressed by the OU3 ROD, 235 acres are lacustrine habitat and 314 are floodplain habitat (Ridolfi and Falter, 2004). The estimated present value cost to clean the 235 acres of lacustrine habitat is $7.8 million, in 2004 dollars (Table G.5, Appendix G, Ridolfi and Falter, 2004). The estimated present value cost to clean the 314 acres of floodplain habitat is $16.3 million, in 2004 dollars (Table G.5, Appendix G, Ridolfi and Falter, 2004). The total estimated cost to clean up federal lands in the lower basin floodplain that are not addressed by the OU3 ROD is $38.6 million, in 2004 dollars (Table G.5, Appendix G, Ridolfi and Falter, 2004).

Federal lands in the upper Coeur d'Alene basin

Ridolfi and Falter (2004) include a calculation of the costs to conduct cleanup of upper basin federal lands, taking into account the cleanup actions specified in the OU3 ROD. Their calculated costs ($54.3 million, in 2004 dollars) are the costs of actions necessary to restore federal lands in the upper basin to baseline conditions.

The remainder of this report presents the calculations of damages specifically for injured upper basin federal lands where the damages are calculated as the cost to replace or acquire the equivalent of the injured resources [43 CFR §11.80(b)]. As described in Chapter 2, damages are calculated for all injured upper basin federal lands, including those that have already been cleaned up and those that are identified for cleanup in EPA's OU3 ROD.

The Trustees are using the cost to replace or acquire the equivalent of the injured resources for several of the injured resources in addition to upper basin federal lands. The cost of replacing or acquiring the equivalent of injured aquatic resources is presented in Lipton et al. (2004b), and the cost of replacing or acquiring the equivalent of the injured swans is presented in Kern (2004).

In summary:

- Damages can be calculated as the incremental cost to restore injured resources to baseline through additional basin cleanup beyond that planned by EPA. Ridolfi and Falter (2004) present these damage calculations for the entire Coeur d'Alene basin, and Trost (2004) presents these damage calculations for federal lands in the lower basin that provide feeding habitat for swans but are not identified for cleanup in EPA's ROD.
- Another approach to natural resource damage determination is to calculate damages as the cost to replace or acquire the equivalent of the injured resources. These damage calculations are presented in separate reports: one for federal lands (this report), one for aquatic resources (Lipton et al., 2004b), and two for swans (Kern, 2004; Trost, 2004).

2. Approach to Calculating Upper Basin Federal Land Damages

This chapter describes the approach used to calculate damages for injured federal lands in the upper Coeur d'Alene River basin, which includes injured federal lands along Canyon Creek, Ninemile Creek, and the South Fork Coeur d'Alene River downstream of mining and mineral processing operations. The approach is based on the cost of replacing the habitat services lost from the injured lands with an equal amount of riparian habitat services improvement gained from restoring ecologically degraded areas elsewhere.

2.1 Habitat Service Losses

The Court ruled in the first phase of the trial that riparian resources on federal lands in the upper basin are injured by hazardous substances. Hazardous substances in the soil and sediment of floodplain and riparian areas are toxic to plants, and cause a marked decrease in plant cover and increase in barren areas. These injuries have resulted in a loss of riparian habitat, including on federal land located in the floodplains of Canyon Creek, Ninemile Creek, and the South Fork Coeur d'Alene River (U.S. District Court, 2003).

Fully functioning riparian habitat provides many ecological services, which are defined by DOI NRDA regulations as "the physical and biological functions performed by the resource including the human uses of those functions. These services are the result of the physical, chemical, or biological quality of the resource" [43 CFR § 11.14(nn)]. As described in the Trustees' Report of Injury Assessment, riparian habitat provides many different services (LeJeune and Cacela, 1999; Stratus Consulting, 2000):

> The riparian zone is the transitional area between the aquatic riverine environment and the terrestrial upland environment. Riparian zones are among the most biologically, chemically, and physically diverse, dynamic, and complex terrestrial ecosystems. The riparian zone regulates the flow of energy and materials between the terrestrial and aquatic environments, and between upstream and downstream reaches of streams. Riparian zones support rich assemblages of plant and animal species. Natural riparian zones buffer erosive stream energy, store flood waters and reduce peak flows, and sequester and reduce bioavailable concentrations of pollutants.

> Riparian vegetation helps stabilize the streambanks through anchoring by root networks, and it reduces water velocity by increasing surface roughness. Riparian vegetation intercepts and stores energy from solar radiation, which influences stream temperature and serves as a source of energy (detrital inputs) for adjacent and downstream aquatic biota. Riparian soils, soil biota, and vegetation together regulate the supply of nutrients to the aquatic ecosystem. Riparian soil and vegetation communities help maintain surface and shallow groundwater quality through physical filtering of sediment and attached nutrients by vegetation, plant uptake of nutrients or pollutants, and biotically controlled reactions in soils that release excess nutrients, particularly nitrogen, as gases to the atmosphere.
>
> Riparian zones typically support highly diverse and productive ecological communities. Riparian habitat provides critical connectivity between upland and aquatic habitats for plant and animal species. Vegetative overhang provides fish food (detritus) and cover, and shades the water from solar radiation. The abundance of water and forage and the compositional and structural diversity of riparian vegetation communities support wildlife species in numbers disproportionate to the area of the riparian zone.

The injured lands included in this damage calculation are barren or significantly degraded by loss of vegetation because of hazardous substances, and revegetation of the lands is precluded or greatly inhibited by hazardous substances in the soil (Stratus Consulting, 2000). As a result of the injuries, the riparian federal lands included in this damage calculation provide essentially no riparian services (Stratus Consulting, 2000):

> Soil phytotoxicity and reductions in vegetation cover have resulted in deterioration of ecological functions, including habitat for all biological resources that are dependent on riparian habitats in the basin; growth media for plants and invertebrates; primary and secondary productivity, carbon storage, nitrogen fixing, decomposition, and nutrient cycling; soil organic matter and allocthonous energy (i.e., carbon from decomposing plant matter) to streams; geochemical exchange processes; food and cover (thermal cover, security cover) for fish, migratory birds, and mammals; feeding and resting areas for fish, migratory birds, and mammals; the migration corridor provided by the riparian zone; habitat for macroinvertebrates; soil/bank stabilization and erosion control; and hydrograph moderation.

Absent the release of hazardous substances from mining and mineral processing operations, the riparian habitat services provided by these injured areas would be similar to those provided by the reference areas described in the first phase of the trial (LeJeune and Cacela, 1999; Stratus

Consulting, 2000). Thus, relative to the reference areas, the injured federal lands have suffered a complete loss of habitat services because of the hazardous substance injuries.

Some of the injured federal riparian lands in the upper basin are targeted for cleanup actions as part of EPA's selected remedies for the basin (U.S. EPA, 1991, 1992, 2002). Where EPA's remedies include actions on federal lands, the federal agency will conduct the cleanup in coordination with other cleanup actions being conducted in the basin. Costs incurred by federal agencies related to actions conducted pursuant to an EPA remedy may be addressed through cost recovery and are not included in any NRDA damage calculations.

EPA's selected remedy for OU3 for riparian source areas of the upper basin prescribes the removal of contaminated soil, followed by soil amendment and planting with native vegetation (U.S. EPA, 2002). Once the vegetation communities in areas remediated pursuant to the OU3 ROD mature to a state similar to the reference areas, restoration to baseline will have been achieved. Therefore, on the injured upper basin federal lands where the EPA selected remedy prescribes these cleanup actions, resources ultimately will be restored to baseline by the planned remedial actions.

Nevertheless, habitat services losses will continue to occur on the injured federal lands until the remedial actions are conducted and post-action recovery is complete. Moreover, only a portion of the injured federal lands will be cleaned up under EPA's remedy. Without cleanup, recovery of these lands to baseline conditions will take centuries (Stratus Consulting, 2000), during which habitat service losses are ongoing.

Hazardous substance injuries to federal lands have caused complete loss of riparian habitat services. The habitat service losses include (1) the past and ongoing losses on lands that will be cleaned up that occur until the cleanup is conducted and post-cleanup recovery is complete, and (2) the past and longer-term ongoing losses that will occur on lands not being cleaned up.

2.2 Replacement of Lost Habitat Services

The riparian habitat services that have been lost because of injury can be replaced through ecological restoration actions that improve degraded riparian habitat elsewhere. Riparian habitat elsewhere in the region has been degraded by agriculture, road building, logging, and other disturbances (LeJeune and Cacela, 1999; Stratus Consulting, 2000). Where riparian habitat has been degraded by these or similar actions, habitat services can be improved through ecological restoration actions that return the degraded habitat to a more natural state. The disturbances that have caused the habitat degradation are removed, and actions are taken to hasten natural recovery to a mature, functioning riparian ecosystem. If the degraded areas currently provide no or essentially no riparian habitat services, and restoration actions restore them to a state similar to reference areas, then the habitat services lost because of the injuries to federal land are replaced.

Restoring degraded riparian habitat in areas other than where the injury has taken place does not restore the injured resources themselves, but rather replaces the injured resources and restores the services that have been lost because of the injury. Restoration of the injured resources themselves can be accomplished through contaminant cleanup and ecological restoration actions, as described in Ridolfi and Falter (2004). In contrast, replacing the lost habitat and services does not change the condition of the injured resources, but it provides an increase in habitat services elsewhere to offset the habitat services lost in the injured areas. Habitat replacement thus is the "substitution for injured resources with resources that provide the same or substantially similar services" [43 CFR §11.82(b)(1)(ii)], and the cost to replace the lost habitat services is a measure of damages [43 CFR §11.80(b)].

Habitat service losses on the injured lands can be quantified in terms of the area over which the losses occurred, the degree of the losses, and the time period of injury. The units of the loss are expressed as area-years of service. The amount of habitat replacement necessary to offset the interim losses is then determined as an equivalent number of area-years of service.[1] In this way, the habitat services gained through replacement offset the interim habitat service losses resulting from the injury. The cost of the amount of habitat replacement necessary to offset the interim losses is then a measure of the interim loss damages.

This approach to calculating interim loss damages is the habitat equivalency analysis (HEA) procedure developed by the National Oceanic and Atmospheric Administration (NOAA) for conducting NRDA damage quantification at oil spills. The technical approach for completing a HEA is presented in a series of published articles (e.g., Chapman et al., 1998; Peacock, 1999; NOAA, 2000; Strange et al., 2002; Strange et al., 2004; Allen et al., in press).

One benefit of HEA is that it explicitly creates a connection between units of services lost because of injury and units of services gained through restoration. The connection provides a clear demonstration that the trustees have fulfilled their mandate of compensating the public for losses of natural resources and their services. HEA is based on the principle that the public can be compensated with direct service-to-service scaling, where the services provided by proposed restoration actions are of similar type, quality, and value as the services lost due to injury (NOAA, 2000).

1. Interim losses are the losses resulting from the injury that occur until restoration to baseline is achieved [43 CFR § 11.83 (c)].

2.3 Calculating Damages

In summary, damages for injured federal lands in the upper Coeur d'Alene basin are calculated as the cost of replacing the injured habitat through ecological restoration of degraded riparian lands elsewhere. The calculation of damages as the cost to replace lost habitat services includes the following steps, which are described more fully in subsequent chapters:

- The habitat service losses resulting from the injury are quantified based on the size, duration, and degree of the losses. The duration of the losses takes into account cleanup actions and natural recovery processes (Chapter 3).
- Next, actions to replace the lost habitat services elsewhere are identified, and the timeline and degree of habitat services gained by conducting the habitat replacement actions are defined (Chapter 4).
- Per unit costs to conduct the habitat replacement actions are determined (Chapter 5).
- The appropriate size or scale of the replacement actions that is necessary to offset the losses is determined through a process called "scaling." The HEA method is used to conduct the scaling. The cost of implementing the scaled actions is then calculated, and this cost is the measure of damages (Chapter 6).

3. Quantification of Injury to Upper Basin Federal Lands

This chapter presents the quantification of injury to federal lands in the upper basin for which replacement costs are calculated. The habitat service losses are quantified based on the number of acres injured, the degree of injury, and the time period of the injury. The time period of injury recognizes that losses have occurred from the onset of injury, and will continue until restoration to baseline is achieved.

3.1 Methods

During Phase 1 of the trial, the Trustees presented a preliminary quantification of upper basin floodplain lands injured by hazardous substances. The quantification was based on mapping of existing vegetation cover in the Coeur d'Alene basin and was conducted by the U.S. BLM (Stratus Consulting, 2000). Injured areas included nonurban areas in the floodplain areas mapped as barren or supporting less than 10% tree canopy cover. To refine the quantification based on the Court's ruling (U.S. District Court, 2003) and recent floodplain and ownership information, geographic information systems (GIS) boundaries were updated, and boundaries of federally owned lands were delineated.

Areas of federal land were identified using a GIS land ownership layer developed by the BLM for federal lands of northern Idaho (BLM, 2002). The land ownership information was used to identify federal lands within the floodplains of:

- the South Fork Coeur d'Alene River from the North Fork Coeur d'Alene River confluence to the confluence of Daisy Gulch (upstream of Mullan, ID)
- Ninemile Creek from its confluence with the South Fork Coeur d'Alene River to the Interstate-Callahan mine, including East Fork Ninemile Creek
- Canyon Creek from its confluence with the South Fork Coeur d'Alene River up to approximately Burke.

GIS was used to quantify areas of injured federal riparian lands (Figure 3.1) and to remove from the injured area quantification all roads and road beds. The quantification of the injured area was conducted using the following:

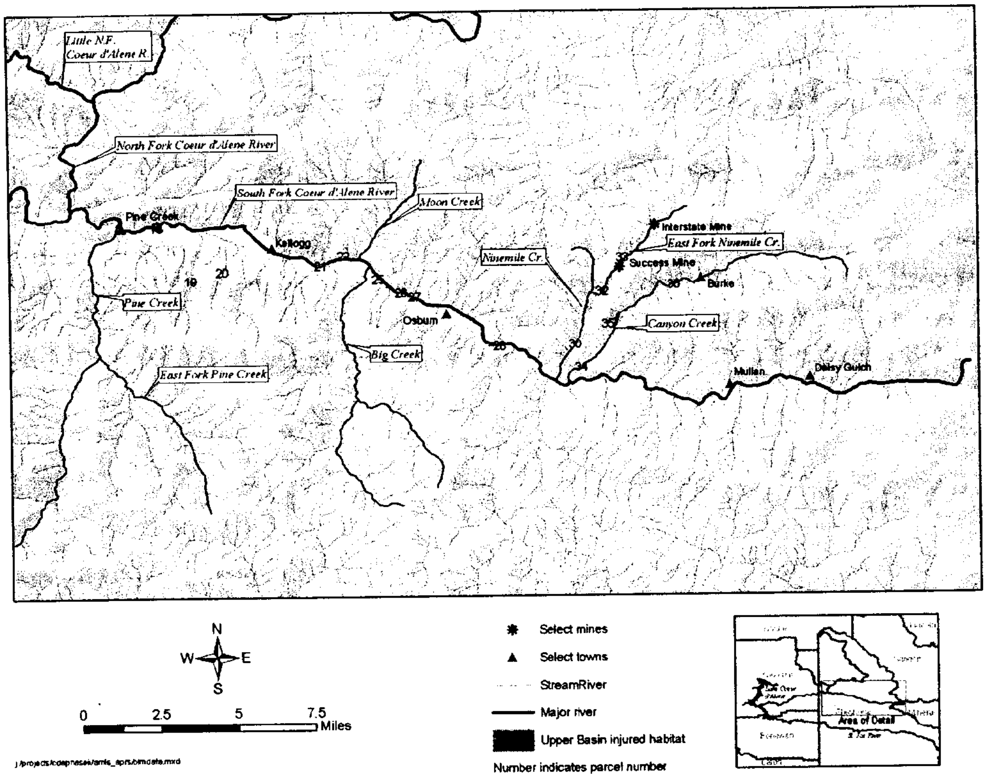

Figure 3.1. Location of injured federal riparian lands. Numbers refer to parcel numbers in Table 3.1.

- High-resolution (1 meter) spatially referenced black and white aerial photographs (DOQs) (USGS, 1992-1995) taken between June 1992 and August 1995.
- High-resolution color aerial photos taken on July 10-11, 2003 (BLM, 2003).
- GIS data sets of vegetative cover and mine site inventory (BLM, 1998, 1999), both of which were presented in Phase 1 of the trial and have undergone extensive field validation.
- Soil and vegetation sampling data from the 1994 sampling (LeJeune and Cacela, 1999; Stratus Consulting, 2000).

Finally, areas of injured federal riparian land targeted for action under EPA's RODs for OU2 (U.S. EPA, 1992) and OU3 (U.S. EPA, 2002) were identified and quantified.

3.2 Results

Results of the quantification are expressed in terms of acres of injured federal riparian land and the timeline, or temporal extent, of the injury.

3.2.1 Acres of injured land

A total of 120.4 acres of upper basin federal land was quantified as injured, and of that total, 15.3 acres will be restored to baseline under EPA's selected remedy for OU3 (Table 3.1).

Table 3.1. Upper basin federal land parcels with injured habitat used in damages calculation

Parcel number and name	Basin	Acres of injured habitat used in damages calculation	Will it be cleaned up under EPA's ROD for OU3?[a]
34. Below Woodland	Canyon Creek	0.6	No
36. Canyon Creek	Canyon Creek	1.4	No
35. Upper Woodland	Canyon Creek	51.1	No
20. Deadwood Gulch	Deadwood Gulch	0.8	No
19. Government Gulch	Government Gulch	1.9	No
33. Above Success	Ninemile Creek	0.7	Yes
32. East Fork Ninemile	Ninemile Creek	10.0	No
30. Ninemile Creek	Ninemile Creek	4.9	No
25. BF Polaris	S Fork Coeur d'Alene River	0.8	Yes
26. Evolution	S Fork Coeur d'Alene River	0.6	No
26. Evolution	S Fork Coeur d'Alene River	4.8	Yes
27. Osburn	S Fork Coeur d'Alene River	0.1	Yes
21. SF Elizabeth Park	S Fork Coeur d'Alene River	6.4	Yes
22. SF Roadside Tailing	S Fork Coeur d'Alene River	3.2	No
28. Silverton	S Fork Coeur d'Alene River	2.4	Yes
18. Smelterville Flats	S Fork Coeur d'Alene River	30.6	No
Total acres of injured habitat used in damages calculation		**120.4**	
Subtotal: Injured habitat that will be cleaned up under EPA's OU3 ROD		**15.3**	

a. Previous cleanup actions are described by parcel in Table 3.2.

Appendix A contains photographs of the injured riparian lands taken between 1992 and 2004. These photographs show continued lack of vegetation, lack of recovery, and ongoing injury through 2004.

3.2.2 Temporal extent of injury

To calculate the interim loss of riparian habitat, the timeline of injury must be defined. The timeline of injury begins in the year in which interim losses began to accrue, and ends in the year in which baseline conditions are achieved (or in 100 years, if recovery takes longer; HEA calculations in this report were truncated at 100 years after the start date). Therefore, the final year for HEA calculations of injury losses and habitat replacement gains is 2110, which is 100 years after the start date for the habitat replacement actions (2010).

The date of enactment of CERCLA was December 11, 1980. We used 1981 as the starting year of the interim loss accrual for upper basin federal lands because 1981 was the first full year of injury after the enactment date. The actual starting point of riparian injury is likely to have occurred decades earlier, given that releases of hazardous substances to the Coeur d'Alene River basin began in the 1880s.

Lands with no cleanup

Without remedial or restoration actions, injured federal lands in the upper basin will remain injured for centuries (Stratus Consulting, 2000). Restoration of baseline services for riparian resources requires three steps: first, the ongoing release and downstream transport of hazardous substances in surface water, groundwater, and sediments must be greatly reduced; second, the contaminated soil/sediment must be naturally covered or diluted with cleaner soil/sediment; and third, riparian vegetation must recolonize and regrow on appropriate substrates so that vegetation cover, species richness, and vegetation structural complexity are equivalent to baseline conditions.

The court found in the Phase 1 ruling that "leaching of hazardous materials from mining waste, including mixed tailings and alluvium in the beds and banks of the rivers and streams of the Basin, occurs whenever mining waste is exposed to elements and this creates a cycle of continuing releases of hazardous substances" [§ II.D.2, p. 12]. EPA's OU3 ROD anticipates that with completion of the selected cleanup remedy in approximately 30 years, downstream transport of metals in Ninemile Creek, Canyon Creek, and the South Fork Coeur d'Alene River will continue for the next 280-1,000+ years (U.S. EPA, 2002). Thus, hazardous substance releases and transport will continue to expose riparian areas for decades after the completion of EPA's selected remedy for the basin, which is scheduled to take 30 years.

Natural recovery time for riparian resources will depend on the time required for floodplain soils to become diluted to nonphytotoxic levels, followed by primary vegetation succession, organic soil development, and development of vertically and horizontally diverse vegetation communities. Once soil and sediment contamination conditions are suitable for plant growth, the establishment of a mature riparian vegetation community will take decades. Recovery of riparian resources includes development of vegetation that will overhang the stream, modulate stream temperatures, and provide security cover for fish. It includes recovery of riparian vegetation to the point where the vegetation provides habitat structure (e.g., large woody debris, bank stabilization) and a source of energy (i.e., detritus) to the aquatic ecosystem. It also includes reestablishment of diverse early and late successional vegetation and the expected range of terrestrial habitat features (e.g., mature tree boles for tree-cavity nesting birds) (Stratus Consulting, 2000).

Existing surface water and sediment data show no evidence of elimination of sources or pathways over the last 20 to 30 years (Status Consulting, 2000; Lipton et al., 2004b). Aerial and ground photographs taken between 1992 and 2004 show the lack of recovery of riparian vegetation in the injured areas (Appendix A). Therefore, it is reasonable to expect that natural recovery of the riparian zone will take hundreds of years.

Therefore, the following timeline of injury and recovery to baseline was used to calculate interim losses on injured federal lands where no cleanup actions have taken place or are planned:

- Injury accrual begins in 1981, the first full year after CERCLA enactment. Beginning at this time the injury is complete and the injured lands provide no riparian habitat services.
- Within the timeframe of interim loss calculations, which extends to 2110, no recovery of these injured areas will occur, and riparian habitat services remain at 0% through 2110.

Lands subject to EPA remedial cleanup for OU3

For injured federal lands that are targeted for cleanup under EPA's selected remedy for OU3, restoration to baseline will occur faster than for lands where no cleanup actions take place. EPA's selected remedy for these areas prescribes the removal of contaminated soil, followed by soil amendment and planting with native vegetation (URS Greiner and CH2M Hill, 2001; U.S. EPA, 2002). These actions will hasten the recovery of these areas to baseline conditions compared to no action and natural recovery.

The selected EPA remedy for OU3 is expected to take 30 years to complete following issuance of the ROD in 2002, although actions will be completed in some areas much sooner (U.S. EPA, 2002). EPA plans to prioritize cleanup actions that address human health issues (U.S. EPA, 2002). No schedule for ecological-based cleanup, such as will take place on injured federal lands, has been developed. Therefore, for the purposes of quantifying interim losses, the completion date used for remedial actions on injured upper basin federal lands is 10 years after the 2002 OU3 ROD, or in 2013.

The EPA remedy for OU3 includes planting of riparian vegetation to help the riparian community become established. With successful plantings the maturity of the community and provision of full riparian services are expected to take several decades, as described in the previous section. Black cottonwood (*Populus trichocarpa*) trees are a typical component of vegetation communities in the Coeur d'Alene basin that are similar to injured areas but for the release of hazardous substances. Cottonwood trees can grow quickly initially, reaching 40 to 50 feet in 10 to 15 years in rich, moist locations (Silen, 1947). In the Willamette Valley, Oregon, black cottonwood matures in 60 years or less (Roe, 1958). Growth is considerably slower in interior locations. We used 40 years as an estimate of the time required for the maturation of black cottonwood to a stage at which it might dominate the canopy; provide shade, hiding, and nesting cover for wildlife; provide mature tree boles (trunks) for cavity-nesting birds; and begin to drop large branches that supply large woody debris to enhance the structural heterogeneity of the floodplain.

Therefore, the following timeline of injury and recovery to baseline is used for calculating interim losses on injured federal lands subject to EPA cleanup actions:

- Injury accrual begins in 1981, the first full year after CERCLA enactment. Beginning at this time the injury is complete and the injured lands provide no riparian habitat services.
- From 1981 until 10 years from the beginning of the implementation of the OU3 remedy, or 2012, the lands continue to provide no habitat services.
- The reestablishment of a baseline riparian habitat community begins in 2013 and takes 40 years to reach maturity, at which time full restoration to baseline occurs. During these 40 years, the habitat services provided by the land increase linearly.

Lands where some cleanup has already occurred

Cleanup actions have already been conducted at 10 of the injured federal land parcels (Table 3.2). Some of these parcels addressed in the past are targeted for additional cleanup actions in EPA's OU3 ROD, and some are not.

An estimate of the time remaining until recovery to baseline is required for calculating interim losses for each of the parcels. The cleanup and restoration actions at Smelterville Flats, which were completed in 2000, are anticipated to result in the recovery of the area to baseline conditions in 2040 (40 years after completion of the revegetation work). For the parcels that are targeted for cleanup under EPA's OU3 ROD (East Fork Ninemile above Success, Silverton, and

Table 3.2. Service recovery timelines for previous cleanup actions conducted on upper basin federal lands

Parcel, drainage	Year of action completion[a]	Description/notes	Service recovery timeline[b]
Smelterville Flats, South Fork Coeur d'Alene River	2000	Contaminated sediment removal (partial), followed by topsoil replacement, partial revegetation. As of 2004, grasses and cattails established.	Linear recovery beginning in 2001 and reaching full services 40 years post-cleanup, in 2040
Below Woodland, Canyon Creek	1995	Time-critical floodplain soil removal and stream reconstruction conducted by Silver Valley Natural Resource Trustees. Soils at removal areas amended with organic materials, then revegetated. Revegetation not successful.	Not expected to recover within 100 years; complete service loss through 2110
Upper Woodland, Canyon Creek	1995	Extensive time-critical floodplain soil removal and stream reconstruction conducted by Silver Valley Natural Resource Trustees. Soils at removal areas amended with organic materials, then revegetated. Revegetation not successful.	Not expected to recover within 100 years; complete service loss through 2110
East Fork Nine Mile, Nine Mile Creek	1994	Time-critical removal of selected floodplain tailings and contaminated sediments conducted by Hecla and Idaho Department of Environmental Quality. Stream reconstruction, riparian stabilization, and revegetation with fescue mats. Revegetation not successful.	Not expected to recover within 100 years; complete service loss through 2110
East Fork Nine Mile above Success, Nine Mile Creek	1994 (2012)	Limited tailings removal in 1994. Area will be addressed by the OU3 remedy.	Linear recovery beginning in 2013 and reaching full services 40 years post-cleanup, in 2052
Deadwood Gulch, South Fork Coeur d'Alene River	1998	Limited remedial work conducted by EPA. Rock dump removal, stream armoring, seeded for revegetation.	Not expected to recover within 100 years; complete service loss through 2110
Government Gulch, South Fork Coeur d'Alene River	1998	Limited remedial work conducted by EPA. Reworked, some soil removal, rebuilt stream channel. Some seeding for revegetation.	Not expected to recover within 100 years; complete service loss through 2110

Table 3.2. Service recovery timelines for previous cleanup actions conducted on upper basin federal lands (cont.)

Parcel, drainage	Year of action completion[a]	Description/notes	Service recovery timeline[b]
Canyon Creek, Canyon Creek	1996	Limited stream reconstruction and tailings removal, followed by grass planting.	Not expected to recover within 100 years; complete service loss through 2110
Silverton, South Fork Coeur d'Alene River	1997 (2012)	Partial tailings removal; some revegetation work, but revegetation incomplete. Area will be addressed by the OU3 remedy.	Linear recovery beginning in 2013 and reaching full services 40 years post-cleanup, in 2052
Evolution, South Fork Coeur d'Alene River	1997 (2012)	Soils removed from part of parcel. Area will be addressed by the OU3 remedy.	Linear recovery beginning in 2013 and reaching full services 40 years post-cleanup, in 2052

a. Years in parentheses indicate that additional response actions will take place at the site in conjunction with the remedy specified in the OU3 ROD (U.S. EPA, 2002). For damages determination, a completion date of 2012 is used.
b. For all timelines that include recovery after a response action, in the last 40 years of recovery the habitat services are increased linearly from 0% to 100% of baseline, reflecting a gradual maturing of the riparian habitat community.
Sources: U.S. EPA, 2002; D. Fortier, U.S. DOI BLM, personal communication, 2004.

Evolution), recovery is anticipated to begin in 2013 and continue until 2052, when baseline conditions are achieved. Past cleanup actions at Below Woodland, Upper Woodland, East Fork Ninemile, Deadwood Gulch, Government Gulch, and Canyon Creek were limited, and these parcels are not slated for cleanup under EPA's selected OU3 remedy. Therefore, for these lands natural recovery will take more than 100 years, and the quantification of interim loss is truncated at 2110.

4. Restoration Project Alternatives

This chapter describes the types of projects considered for replacing riparian habitat through restoration of degraded lands elsewhere. The benefits that the project alternatives provide, or the services that are expected to be provided as a result of the project, are also described.

4.1 Project Types

The Trustees considered types of restoration actions that would result in significant and substantial increases in riparian vegetation cover. The restoration alternatives considered were types of actions that would ultimately "provide the same, or substantially, similar services" [43 CFR § 11.82(b)(2)] as the services lost as a result of the injuries. The restoration alternatives considered range from riparian land protection and encouragement of natural revegetation of disturbed lands, to active restoration actions in locations where anthropogenic disturbance has removed riparian vegetation. The four project types considered include:

- acquisition of a conservation easement on land and active restoration to reference conditions
- acquisition of a conservation easement on land and natural recovery to reference conditions
- road and railway bed removal
- placer mine restoration.

Identification of appropriate ecological restoration alternatives was conducted in conjunction with the identification of alternatives for the aquatic resources damage calculation (Lipton et al., 2004b). For each alternative, a timeline of the riparian habitat service benefits expected to accrue from the alternative was developed so that the habitat services gained over time could be quantified.

Section 4.2 describes riparian vegetation successional dynamics, or the expected natural dynamics of riparian ecosystems in the reference areas, and the anticipated dynamics of recovery in remediated or restored areas of floodplain. These characteristics of vegetation succession to reference conditions are used in Section 4.3 to estimate the timeline and trajectory of recovery to baseline conditions of the four project types.

USEXRPT000300

4.2 Project Benefits Background: Vegetation Succession and Ecological Restoration

Riparian vegetation succession occurs naturally, as herbaceous plants establish and stabilize newly exposed soils. The roots of herbaceous plants and shrubs stabilize soils and sediments of the banks and floodplain, allowing time for growth of larger riparian shrubs and trees. Over time, tree species such as the rapidly growing black cottonwood (*Populus trichocarpa*) and the slower-growing grand fir (*Abies grandis*) dominate the canopy and begin to senesce. As a multistoried vegetation community develops, the vegetation community begins to supply the floodplain and stream channel with the large woody debris that is important for maintenance of natural stream flow dynamics.

Riparian succession is punctuated with frequent flood events that reset succession in hydrologically active zones of the floodplain. Plant communities and the floodplain on which they establish are closely interrelated: the species composition of the community is closely linked to the age, flood frequency, and subsequent stability of the underlying surface. Regular flooding, the associated transport and deposition of sediments, and frequent, rapid channel changes are natural and desirable. On streams with sufficient diversity and cover of riparian vegetation, sediments, seeds, and other plant propagules are deposited during high flows and contribute to increased compositional and structural diversity in the riparian vegetation community. Occasional high energy flood events that scour sections of the riparian zone, change the channel path, and reset succession create complex patterns of vegetation age and composition that contribute to desirable habitat heterogeneity.

4.2.1 Successional trajectories

Riparian plant establishment typically begins rapidly after a disturbance is removed. Establishment of herbaceous cover is the first stage in the natural revegetation process. As vegetation succession progresses, plant compositional diversity increases, and growth of woody vegetation increases the structural heterogeneity of the community. In approximately 25 to 30 years, depending on the frequency and type of natural disturbances and climate, the full species diversity of the adjacent riparian flora is typically present. Black cottonwood can dominate the canopy by approximately 40 years; provide shade, hiding, and nesting cover for wildlife; provide mature tree boles (trunks) for cavity-nesting birds; and may begin to drop large branches that contribute to habitat complexity in the herbaceous layer.

Riparian succession is rarely completely linear. Seasonal high water events of varying magnitude shape parts of the riparian community annually, while more infrequent events such as 25- and 100-year floods influence areas of the floodplain more distance from the active channel. This topographic and hydrologic heterogeneity is reflected in the composition and structure of natural riparian vegetation communities. Depending on the actual frequency of larger flood events, succession on areas of the floodplain more distant from the active channel may rarely be reset by flooding. Such areas typically support the most mature vegetation communities.

Spatially, therefore, succession on a small scale (e.g., 10 m) may be interrupted by frequent disturbance. A hypothetical trajectory of a given location on the floodplain might show a resetting of succession, periodically or sporadically, back to initial or intermediate stages. However, integrated over the whole width of the floodplain, succession toward a mature and diverse community can be monotonic, if not linear, until a catastrophic flood resets succession across the floodplain.

Clearly, natural systems are complex and may have numerous possible successional "destinations" (Anand and Desrochers, 2004), depending, for example, on initial conditions, intermediate disturbances, particular sequences and patterns of plant establishment, and the scale of measurement. For quantifying successional trajectories and estimating the services provided by naturally recovering and actively restored riparian ecosystems, we estimate that, integrated across the floodplain, development of the characteristics of reference riparian communities is approximately linear, and the services provided by the riparian community increase linearly from no services to full services (baseline conditions) as the vegetation community gradually matures. Baseline conditions were defined during the first phase of the trial as the conditions existing at reference sites on the Little North Fork Coeur d'Alene River, upper Ninemile Creek, and upper Canyon Creek (Stratus Consulting, 2000):

> The reference areas selected are riparian corridors of similar size and orientation, with similar climate, topography, soil parent material, and history. The vegetation types, species composition, plant cover, and structure within each of the reaches is representative of the vegetation types, species composition, plant cover, and structure that should exist in the assessment area. The reference areas have been subjected to anthropogenic alterations including road building, logging, mining-related disturbances, and recreational and residential impacts. Where possible, reference reaches were located upgradient of assessment reaches. Where upstream areas were not appropriate, a reference reach was identified based on proximity to the assessment reach, comparable elevation, and comparable valley orientation.

4.2.2 Riparian ecosystem restoration

The goal of ecological restoration is to initiate the recovery of a damaged ecosystem by creating conditions that will prompt the ecosystem to follow its natural development pathway (Jordan et al., 1996; SER, 2002). The recovery trajectory should lead the ecosystem toward a condition similar to a reference ecosystem that is believed to represent what would be the current state of the ecosystem had it not been disturbed (SER, 2002). Ecological restoration is often desirable because under a new set of ecosystem-shaping conditions, the ecosystem might never recover to its natural state, or recovery may take a very long time.

For example, natural succession to a state at which mature trees dominate the canopy and begin to provide woody debris to the forest floor and the stream channel can occur in several decades, depending on initial conditions, the rate of growth of the specific tree species, climate, and disturbances. In a disturbed area targeted for restoration, where agricultural practices, grazing, or other regular disturbances have homogenized or otherwise modified the vegetation community, natural succession in parts of the floodplain could occur rapidly with optimal flooding conditions, or it could take many years to initiate during a drought cycle. If a 25-, 100-, or 500-year flood event, which would remove existing nonriparian vegetation and establish conditions suitable for growth of riparian vegetation, did not occur for many years, then a large part of the floodplain might not initiate recovery for a long time.

Riparian restoration can include floodplain reshaping, removal of existing undesirable vegetation, and planting of a wide range of species in patterns resembling a natural and complex distribution of vegetation types. Restoration actions are targeted, as closely as possible, to mimic species composition and community patterns that would reflect the natural mosaic created by repeated floods of varying magnitude. Therefore, active restoration can speed recovery of mature and complex riparian ecosystems by imparting species and structural complexity initially that would otherwise take decades to occur naturally. Moreover, though ecological restoration cannot significantly speed the growth of plants, it can establish favorable initial conditions for growth.

Figure 4.1 shows hypothetical recovery trajectories to reference conditions for an area of floodplain previously used for grazing that is actively restored (a) and left to recover naturally (b). The more gradual recovery of the area left to recover naturally takes longer because the mosaic created by repeated floods of varying magnitude will take many years to imprint on the landscape. Events that create conditions favorable for establishment of cottonwoods or other arboreal species may not occur in parts of the floodplain for many years. For both actively restored areas and naturally recovering areas, we use the approach that, integrated across the floodplain, development of the characteristics of reference riparian communities is approximately linear.

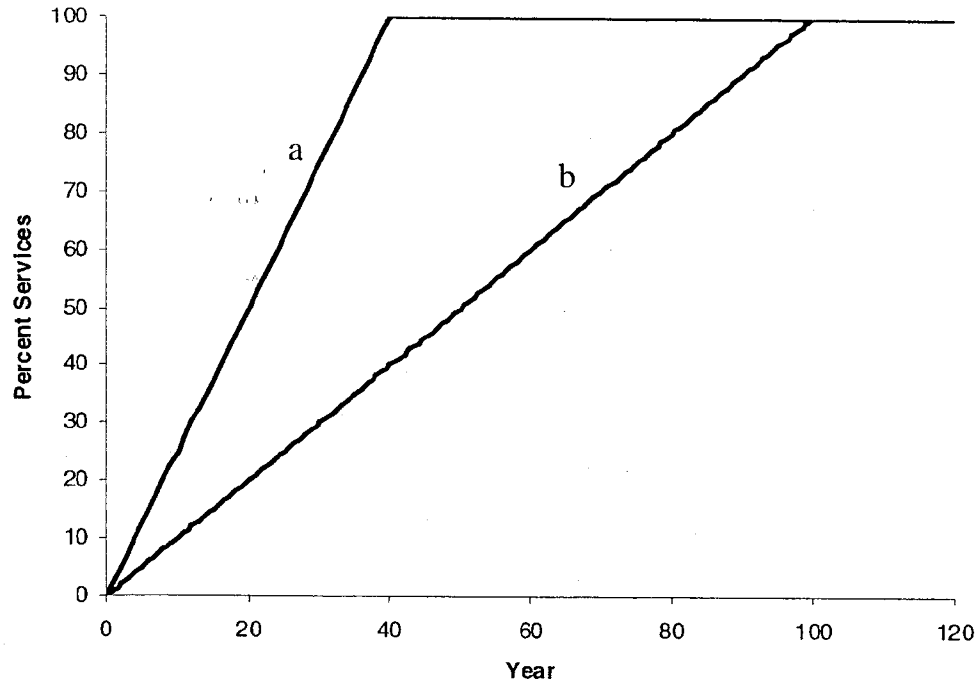

Figure 4.1. Recovery curves for riparian habitat services for (a) active planting and (b) natural recovery.

4.3 Project Type Descriptions and Benefits

4.3.1 Acquisition of a conservation easement on land and active restoration

A conservation easement is a restriction placed on a piece of property to protect the resources (natural or artificial) associated with the parcel. The easement is either voluntarily sold or donated by the landowner and constitutes a legally binding agreement that prohibits certain types of development (residential or commercial) from taking place on the land for a specified time or in perpetuity. An easement does not grant ownership, and it does not absolve the property owner from usual owner responsibilities such as property tax, upkeep, maintenance, and improvements.

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Conservation easements are one of the most powerful and effective approaches available for environmental conservation on private lands. Conservation easements have successfully protected millions of acres of wildlife habitat and open space, keeping them in private ownership and generating significant public benefits. Conservation easements are among the fastest growing methods of land preservation in the United States today, and their use is increasing in Latin America, the Caribbean, Canada, Australia, and the Pacific (TNC, 2004).

Numerous examples of conservation easements illustrate the benefits of the method for protecting habitat value, protecting lands from unwanted development, and, at the same time, permitting certain valued land uses (TNC, 2004):

- Conservation easements have been used to buffer Yellowstone, Canyonlands, Shenandoah, Glacier, and other national parks and public lands. As buffers, easement lands can help protect migratory corridors for elk, wolves, bears, and other animals that do not confine their movements to the boundaries of a national park or national forest.
- Conservation easements are used to conserve watersheds and aquifers, helping ensure a clean supply of water for public use, including drinking and secondary uses.
- Conservation easements have helped protect open space in rapidly growing urban and suburban areas. Open space preserves scenic beauty, supports quality tourism, and enhances the well-being of local communities and their residents.
- Conservation easements also have been instrumental in preserving agricultural lands, from family farms to ranches to timberlands.

Idaho is a member of the Forest Legacy program and has Forest Legacy Areas that include the "Northern Panhandle" area encompassing Boundary, Bonner, Kootenai, Shoshone, and Benewah counties. The program allows the purchase of easements to ensure that lands enrolled in the program remain as forest in perpetuity. Some of the goals of easements identified in the Forest Legacy program are to "conserve and enhance water quality and water quantities associated with forested landscapes, maintain riparian and wetland areas, and conserve and enhance wildlife habitat and maintain habitat connectivity" (Idaho Department of Lands, 2004).

By selling a conservation easement, a landowner can ensure that the property will be protected forever, regardless of who owns the land in the future. The landowner retains full rights to control and manage the property within the limits of the easement. The easement holder monitors the property to ensure compliance with the easement's terms, but it has no other management responsibilities and exercises no direct control over other activities on the land.

Under this approach purchase of easement restrictions would allow for restoration or recovery of naturally functioning riparian zones along the North Fork and Little North Fork Coeur d'Alene rivers (or similar rivers in the region). Parcels that are degraded because of anthropogenic uses such as agriculture would be protected through purchase of a conservation easement. The easement would limit all development and specific land uses on the property, extractive uses of the property (e.g., logging, mining), and would allow for limited public access.

Active restoration of the vegetation would include removal of existing undesirable vegetation and planting of a wide range of species in patterns resembling a natural and complex distribution of vegetation types. The revegetation plan would target reference area species composition and community patterns to reflect the natural mosaic created by repeated floods of varying magnitude. During the removal of existing vegetation and preparation of the soil for revegetation, some recontouring of the floodplain surface may be needed to restore the natural hydraulic connectivity. Revegetation would include seeding of herbaceous species and planting of shrubs and trees. Soil amendments, including mulch, would be added as necessary to create favorable conditions for plant survival and growth in the early years. Large woody debris would be placed on the floodplain to increase habitat complexity. The large woody debris would also deflect current during high water around specific planted areas to generate channel patterns as might develop naturally over time. Figure 4.2 shows a revegetated floodplain in Washington, years 1 and 7 after restoration.

Figure 4.2. Salmon Creek, Washington, revegetation of a created floodplain, years 1 (left) and 7 (right). Photographs from the Koonce archives; project by Interfluve, Inc.

USEXRPT000306

The ecological recovery trajectory for this project type is based on the time required to attain the maturity of vegetation and mosaic of vegetation composition and structure present in the reference areas on the Little North Fork Coeur d'Alene River, upper Ninemile Creek, and upper Canyon Creek. As described above, restoration actions will hasten the recovery of a structurally and compositionally diverse riparian habitat that provides full services. For modeling purposes, the services provided by the riparian community increase linearly from no services to full services (baseline conditions) as the vegetation community gradually matures. We used 40 years as an estimate of the time required for the maturation of a black cottonwood community to a stage at which black cottonwood trees dominate the canopy; provide shade, hiding, and nesting cover for wildlife; provide mature tree boles (trunks) for cavity-nesting birds; and begin to drop large branches that supply large woody debris to enhance the structural heterogeneity of the floodplain. At 40 years, the restored areas will resemble the reference communities as they existed in 1994 when the original injury determination sampling was conducted to characterize baseline conditions (LeJeune and Cacela, 1999; Stratus Consulting, 2000).

To investigate the potential scope of lands available for conservation easement, we conducted a GIS analysis to identify candidate lands in the Coeur d'Alene and neighboring basins. We limited the search to lands with environmental characteristics similar to the injured lands (i.e., topography, vegetation cover, stream size). Using a GIS, we examined riparian lands in the following drainages:

- the mainstem and all tributaries of the St. Joe River from the headwaters downstream to the town of St. Maries
- the mainstem and all tributaries of the St. Regis River from the headwaters to the town of St. Regis
- all tributaries on the western side of the Clark Fork River from the town of Thompson Falls to Lake Pend Oreille
- the mainstem and all tributaries except Prichard and Beaver creeks of the North Fork Coeur d'Alene River, and the Little North Fork Coeur d'Alene River from the mouth to the headwaters
- the mainstem and all tributaries of Fourth of July Creek
- the mainstem of Big Creek and the West Fork of Pine Creek along the South Fork Coeur d'Alene River.

The streams were identified using the National Hydrographic Dataset (USGS, 2002). The following criteria were applied to identify candidate riparian areas:

- Lands must have a slope no greater than 5 degrees
- Lands must lie within a buffer distance of 250 meters per side on the streams named above and 100 meters per side on all tributaries
- Lands must be in private ownership
- Lands must be classified as nonforested vegetation types (e.g., grassland/herbaceous, pasture, agriculture, fallow, barren).

Individual GIS layers were developed for each of the criteria listed. The slope layer was developed by combining 30-m National Elevation Dataset layers for Montana and Idaho and calculating slopes (University of Idaho Library, 2000; Montana State Library, 2002). The private ownership layer was developed by combining private ownership data acquired for Idaho and Montana (BLM, 2002; MTNHP, 2004). The layer of land use and land cover (LULC) data was developed by combining GAP data for Idaho (University of Idaho, 1999) and National Land Cover Data (NLCD) for Montana (USGS, 2000). Once the LULC layer was combined, only the nonforest cover types were used to create the final layer. After each layer was developed, the five individual layers were overlaid in the GIS to quantify the total amount of habitat meeting the criteria developed.

A total of 6,864 acres satisfied all the criteria; these are considered lands potentially available for purchase of conservation easement. These lands could provide enhanced riparian habitat services if they were to be revegetated, either actively or through natural recovery, and protected in perpetuity. Actual availability of acreage would depend on the willingness of landowners to sell a conservation easement. Nevertheless, the analysis indicates that ample land is available for implementation of this project type in and adjacent to the Coeur d'Alene River basin.

4.3.2 Acquisition of a conservation easement on land and natural recovery

This project type is the same as the one described above, but does not include actions to restore the floodplain or vegetation. Parcels that are similar to the reference areas but for anthropogenic uses such as agriculture would be protected through purchase of a conservation easement. The easement would limit all development and specific land uses on the property, and extractive uses of the property (e.g., logging, mining), and would allow for limited public access.

The property would be protected from use, but the vegetation and floodplain contours would be left to reestablish naturally. Natural succession in parts of the floodplain could occur rapidly with optimal flooding conditions, or it could take many years to initiate during a drought cycle. If a 25-, 100- or 500-year flood event, which would remove existing nonriparian vegetation and establish conditions suitable for growth of riparian vegetation, did not occur for many years, then large parts of the floodplain might not initiate recover for a long time.

The ecological recovery trajectory for this project type is based on the time required to attain the maturity of vegetation and mosaic of vegetation composition and structure present in the reference areas. Without active restoration, the time to maturity will depend in part on flooding frequency and magnitude. For quantifying recovery we used a conceptual model that the restored community will begin to provide riparian services near the active channel in the first year after protection, but the increase in services provided across the floodplain will be gradual. The compositional and structural mosaic created by repeated floods of varying magnitude will take many years to form, and events that create conditions favorable for establishment of cottonwoods or other arboreal species may not occur in parts of the floodplain for many years. Therefore, under this conceptual model natural recovery begins in year one, and provision of riparian services increases more gradually than in planted areas, taking approximately 100 years to reach reference conditions (Figure 4.1, line b). Depending on the level of initial disturbance, this estimate of time to recover could be quite optimistic. Many of the streams on which easements could potentially be acquired are highly channelized, are entrenched, and no longer have a natural flooding regime. However, since those are the conditions that we would expect in the injured areas absent the hazardous substances, they nevertheless seem appropriate for replacement options.

4.3.3 Removal of roads and railway beds in the riparian zone

Where roads or railways run through the riparian zone, removal of the roadbed and recovery of natural riparian vegetation can restore ecosystem services precluded by the presence of the road. An assessment of the Coeur d'Alene River basin found that encroachment of roads on stream channels and floodplains has "compromised the ability of streams and riparian areas to adequately and safely transport water and natural sediments, maintain clean water, moderate floods, and provide quality habitats for aquatic life" (Idaho Panhandle National Forests, 1998). In addition, the roads themselves occupy a portion of the floodplain that would otherwise provide riparian habitat.

Road removal to restore direct habitat loss, terrestrial and aquatic habitat connectivity and quality, and ecosystem processes, and to limit human-related disturbance has become common practice for public and private land managers in the United States and Canada (Trombulak and

Frissel, 2000; Switalkski et al., 2004). Land managers recognize the ecological benefits that road removal can provide.[1]

Road removal is such a sufficiently routine need that many land management agencies have their own protocols for road removal and subsequent habitat restoration. Road removal typically includes removing the road fill, decompacting the roadbed, recontouring the floodplain where the road is removed, and placing large woody debris or other conventional erosion controls to anchor the new floodplain structure while vegetation establishes. Many miles of roadway have been removed or otherwise modified in this way, and many examples are found on National Forests throughout the Pacific Northwest (Figure 4.3).

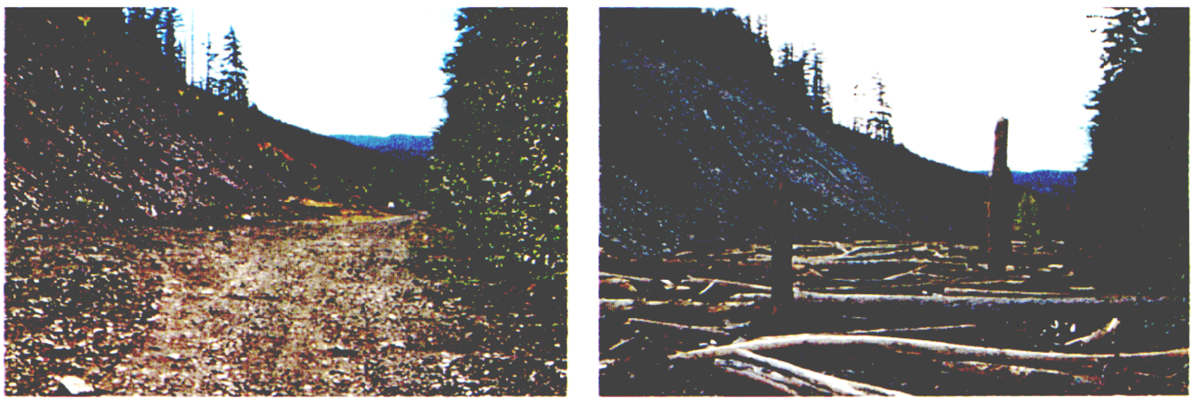

Figure 4.3. Removal and restoration of roadway on a floodplain, Clear Creek, Oregon. Photographs from the Koonce archives; project by Interfluve, Inc.

In the North Fork Coeur d'Alene basin, the USDA Forest Service has identified 681 miles of roads that encroach on the riparian zone (data provided by R. Patten, forest hydrologist, Idaho Panhandle National Forests, using 30 m Digital Elevation Model data prepared for the Idaho Panhandle National Forest). Ample opportunity exists for road removal projects in the Coeur d'Alene basin (Idaho Panhandle National Forests, 1998). The USDA Forest Service is committed to road removal, and supports this type of well-developed, generally accepted restoration action to provide riparian benefits on federal land.

1. For example, the USDA Forest Service revised its road management policy in 2001 to include requirements for science-based transportation analysis, minimization of environmental impacts of roads, and restoration of ecological processes adversely affected by roads [66 FR 3206, 1/12/01] (USDA FS, 2001).

The objective of this restoration project type is to remove obsolete roads and railways from the riparian zone and create conditions that encourage natural revegetation of the riparian habitat. The goal is to restore fully functioning riparian habitat in areas where vegetation is currently lacking because of the presence of an encroaching road.

Benefits of this project include additional area of riparian habitat in the footprint of the road removed and reduction of human disturbance associated with the road and road traffic. Depending on the location of the road, its removal can reduce habitat fragmentation, and for encroaching roads that contribute sediment to the adjacent stream or channelize the stream, removal of the road may also improve aquatic habitat (Lipton et al., 2004b).

Recovery for this alternative is anticipated to be rapid because of the proximity of adjacent vegetation and the narrow footprint of the disturbance caused by the road bed removal. The adjacent vegetation will provide protection from desiccation; a ready source of seeds, propagules, and vectors of seed dispersal (e.g., birds, small mammals); and a source of soil biota to colonize the disturbed area. Therefore, vegetation recovery is expected to begin naturally and rapidly after project implementation. For purposes of quantifying the recovery, we used the conceptual model that services would increase linearly from no services in year one to baseline services in year 40. By year 40, vegetation on the former road footprint will have matured to a multistoried, heterogeneous community similar to reference conditions.

4.3.4 Restoring riparian habitat disturbed by placer mining

Placer mining for gold has disturbed many acres of riparian habitat in the North Fork Coeur d'Alene River and St. Joe River basins. Placer mining typically leaves channelized streams, eroding banks, and, in the floodplain, artificial ponds, altered topography, and barren or sparsely vegetated ground. Excavation and placement of material throughout the floodplain during mining often created mounds of rocks and dredge tails and depressions that alter the hydrological function of the stream and impede the natural recovery of the riparian habitat.

The proposed project type is to identify and restore fully functioning riparian habitat in areas of the North Fork Coeur d'Alene River and St. Joe River that were historically placer mined. The project would restore natural hydrologic, geomorphic, and vegetation conditions of the stream corridor and floodplain. Components of the project would include removing wastes and abandoned machinery, recontouring the floodplain to achieve a more natural configuration, replacing soils and sediments to mimic a natural depositional floodplain, reconstructing the stream channel so that it functions as a natural stream, and revegetating the riparian habitat in the floodplain.

Recontouring of the floodplain would involve removing the rock piles, dredge tails, pits, and undesirable vegetation, and would restore natural channel sinuosity, stable banks, and floodplain contours. Floodplain material would be screened to separate appropriate substrate types for replacement on the recontoured floodplain surface. Native riparian vegetation would be planted to create a structurally and compositionally diverse habitat. Revegetation would include seeding of herbaceous species and planting of shrubs and tree species. Soil amendments, including mulch, and erosion control, would be added as needed. Large woody debris placements in the floodplain would contribute to habitat structure and future natural functioning of the stream and riparian zone. This project would not include actions to restore instream aquatic habitat.

Benefits of this project type include restoration of riparian areas that currently provide greatly diminished riparian services. Because these areas no longer flood naturally, and are not following natural successional pathways, the riparian vegetation will never reach the reference condition. With active restoration of vegetation through replanting, a fully functioning riparian habitat may be restored.

The ecological recovery trajectory assumed for this project type is based on the time required to attain the maturity of vegetation and mosaic of vegetation composition and structure present in the reference areas. For modeling purposes, the services provided by the riparian community increase linearly from no services to full services (baseline conditions) as the vegetation community matures (Figure 4.1, line a). We used 40 years as an estimate of the time required for the maturation of a black cottonwood community to provide the structurally and compositionally diverse conditions that exist in the reference areas.

5. Cost of Replacement

This chapter describes the cost of replacing the injured riparian habitat on federal lands with restoration of degraded riparian habitat elsewhere. The costs developed in this section are presented on a per-acre basis. Sections 5.1 through 5.4 present cost components relevant to the four alternatives described in Chapter 4, and Section 5.5 presents cost estimate totals for each alternative.

5.1 Conservation Easement Costs

To estimate the cost of a conservation easement in the upper Coeur d'Alene basin, we examined the cost of riparian land in the upper basin and the cost of conservation easements recently purchased in the area relative to the appraised value of the land. Details of the evaluation are presented in Appendix B.

To estimate the cost of riparian property, we relied on data from recent transactions of land comparable in type to that being offset. Since there have been relatively few recent transactions in the upper Coeur d'Alene basin, we also incorporated information about lands currently available for purchase, and appraisals. The search included lands with riverfront property along the following waterways: North Fork and South Fork Coeur d'Alene rivers, Fourth of July Creek, Douglas Creek, Wolf Lodge Creek, and Fernan Creek. List price and sales price are often similar, but they are often not the same. We adjusted the list price of lands still for sale by reducing the offer price by approximately 15%, to approximate the same observed price reduction in purchased lands.

The main attribute of concern for acquired lands in the upper basin is the total riverfront area. Parcels with relatively small riverfront access are less preferred than parcels with relatively larger riverfront areas. Because price per acre is typically lower for large parcels (e.g., greater than 100 acres) compared to small parcels (e.g., in the 2-5 acre range), we limited our dataset to parcels over 10 acres.

Table 5.1 shows the data evaluated to estimate a reasonable price per acre of lands similar to the injured lands in the upper Coeur d'Alene basin. The average price of riverfront property is $5,154 per acre.

To estimate the cost of a conservation easement relative to the cost of the land, we reviewed the costs of easements in the Coeur d'Alene basin recently purchased by the USDA, The Nature Conservancy, and the Idaho Department of Lands. All of the easements recently purchased or

Table 5.1. Summary of land transactions and prices per acre

Status	Location	Acres	Asking price	Selling price	Description	Price per acre (rounded)
Sold	St. Joe	103	$210,000	$180,000	Riverfront large parcel	$1,750
Sold	St. Joe	103	$210,000	$202,000	Riverfront large parcel	$1,960
Sold	Rose Lake	142		$210,000	In 100-yr floodplain; protected by road	$1,480
Sold	South of Cave Lake	262		$280,000	Cleared pasture and cutover timber	$1,070
Sold	Latour Creek	80		$165,000	Floodplain	$2,060
Sold	South Fork	15	$60,000	$40,000	Riverfront small parcel	$2,670
On market	South Fork	500	$3,750,000	$3,110,000	Prime rec. parcel, part of larger lot	$6,210
On market	Marie Creek	97	$349,000	$289,000	Creek front, some level with hillside	$2,980
On market	Old River Road	10	$399,000	$330,600	Riverfront small parcel	$33,100
On market	Eagle Creek	10	$49,900	$41,300	Riverfront small parcel	$4,130
On market	Eagle Creek	10	$54,900	$45,500	Riverfront small parcel	$4,590
On market	North Fork	355	$850,000	$704,000	Riverfront large parcel	$1,990
On market	Fourth of July Creek	144	$399,000	$330,600	Creek front, mostly level	$2,300
On market	South Fork	80	$575,000	$476,000	Riverfront large parcel	$5,960
Average						$5,150
Maximum						$33,100
Minimum						$1,070

pending were in the lower basin. However, we used the ratio of the easement cost to the appraised value of the land to determine how much an easement would cost on land valued at $5,154 per acre.

The USDA Wetland Reserve Program (WRP) offers landowners payment in exchange for an easement to create or restore wetlands on the owner's property. The amount of payment is the appraised value of the property or the program "cap" set by USDA, whichever is lower. Currently, the cap is $1,500 per acre. Three easements recently purchased by the WRP in the St. Joe region were each paid at the market value of the land. The appraisal values were $1,426 per acre (Shingle Creek Appraisals, 1997a), $800 per acre (Shingle Creek Appraisals, 1997b), and $975 per acre (Morse & Company, 2003). In each of these examples, the cost of the easement was equal to the value of the property.

The Nature Conservancy (TNC) is an active participant in the placement of conservation easements on timbered lands in northern Idaho. TNC currently purchases easements at the appraised easement price or less. In 2001, TNC placed a easement on approximately 337 acres of land from Crown Pacific Timber Company in the Panhandle National Forest, Boundary County. At the time, the appraised market value of the land was $505,000. With the easement in place and developmental right prohibited, the land was appraised at $202,000. Thus, the value of the easement is $303,000, or $899 per acre, or 60% of the value of the land. The easement on the Crown Pacific lands allows a managed timber practice as well as recreational access. If the conservation easement prevented these uses as well, the encumbered value of the land would decrease even further.

In 2003, the Idaho Department of Lands became involved in the purchase of conservation easements through the Forest Legacy program. An easement agreement with Potlatch Timberlands Corporation secured 2,710 acres in the Mica Creek drainage, a remote area of the St. Joe River valley, for public access in perpetuity, while allowing sustainable wildlife and timber management. The easement purchase price was $600,000, or $221 per acre. The easement prevents Potlatch Corp. from exercising its development rights, which are worth about $600,000 (Sandy Emerson, Emerson Valuation, personal communication, July 27, 2004). Before the conservation easement was placed on the property, the 2,710 acres was appraised at $400 per acre, or $1.08 million. Thus the development rights easement accounted for approximately 55% of the total value of the property.

A fairly unrestrictive easement can account for 50% of the value of a parcel of land, and very restrictive easements, such as the WRP easements, can account for 100% of the property value. These estimates of the value of conservation easements were confirmed through conversations with two local appraisers (Stacey Stovall, Conservation Innovations Inc., and Sandy Emerson, Emerson Valuation, personal communications, August 19, 2004). For purposes of this evaluation, we estimated that a restrictive easement will account for between 50% and 100% of the property value. We estimated that easement value of the type needed to protect riparian habitat in the Coeur d'Alene basin ranges from $2,577 per acre to $5,154 per acre. For damage calculations, we use a midpoint estimate of 75% of property value at $3,866 per acre.

5.2 Active Replanting Costs

Two of the habitat replacement alternatives require active replanting of riparian vegetation: conservation easement with replanting, and placer mine rehabilitation. Unit costs for replanting have been gathered from a variety of sources, including RS Means Heavy Construction Cost Data; recent bids received or reviewed by Interfluve, Inc. on similar project types; and professional opinion. Other costs are included as a percentage of the construction cost and are based on recent bids received or reviewed by Interfluve, Inc. and professional opinion. The cost items included as percentages of total construction costs are:

- Mobilization of equipment and labor to and away from the construction job site.
- Design of the project, including completion of design plans and specifications.
- Contingency for additional costs that are dependent on site-specific conditions. These additional costs arise from site-specific conditions such as the nature of the subsurface materials (e.g., presence of bedrock), the level of the groundwater table, the presence of contamination or artificial structures on site, site access limitations, or other project design restrictions that arise from site-specific considerations. These additional costs cannot be specified in advance at this phase of project cost estimation, but can only be specified once the project site has been selected, the site-specific conditions are characterized, and the project design considerations are better understood.

These costs are estimated as percentages of construction costs because they vary with the overall size or scope of the job. The percentages used for these cost items in this report are selected to represent the overall averages of these costs when the projects are implemented numerous times at numerous places. This approach to including these cost items as percentages of construction costs is a standard practice in the environmental restoration field.

Replanting costs depend on the scale of the effort, required site preparation, planting technique (machines vs. hired hand labor vs. volunteer hand labor), and long-term maintenance costs. Direct costs include site preparation, plant materials and installation, and long-term maintenance. Indirect costs may include negotiation of water management or fencing, where livestock exclusion is necessary. Additional costs will be incurred if significant channel and floodplain restoration is required to restore a functional riparian hydrologic regime (e.g., if the stream is incised or the floodplain has been filled or levied). In some cases, revegetation costs are cheaper in the long term, due to reduced maintenance and replanting costs, if extra money is spent initially to purchase larger plant materials, install browse protection, or implement an irrigation plan. Use of heavy equipment to create deep trenches to plant high-density willow clumps is often less expensive than spreading more labor-intensive hand-planted individual cuttings uniformly over a broad area.

Table 5.2 shows the per-acre costs for planting areas with riparian plant seedlings. Costs include costs to amend the soil, plant trees and shrubs, seed herbaceous species, and place large woody debris across the rehabilitated area to help create favorable and more natural hydraulic conditions across the surface during flood events. The costs also include construction mobilization and demobilization costs, design, and contingency for additional site-specific costs, all expressed as a percentage of construction costs. The total cost for conducting vegetation planting as a component of a habitat replacement alternative is $131,500 per acre. The costs shown in Table 5.2 are based on standard industry practices for developing project planning costs.

Table 5.2. Riparian vegetation replanting per-unit costs

Item[a]	Unit cost	Units/acre	Cost/acre
Soil amendment	$0.25/ft^2	43,560	$10,900
Tree/shrub/seeds	$1.00/ft^2	43,560	$43,600
Large woody debris	$450/piece	70	$31,500
Construction mobilization/demobilization	3% of construction costs		$2,590
Design	10% of construction costs		$8,590
Contingency for additional site-specific costs	40% of construction costs		$34,400
Total cost per acre			**$131,500**

a. Costs shown include raw materials and labor and equipment costs.

5.3 Road and Railway Bed Removal Construction Costs

The road and railway bed removal habitat replacement action involves the removal and offsite disposal of the road/railway surface and underlying road base. The source and basis of unit construction costs and additional costs are the same as those described in Section 5.2 for replanting costs.

Costs for road/railway bed removal projects vary based on the size or volume of the fill removal and on the equipment needed to access to the site. Generally projects can be accessed from one end of the removed road only, and this makes for a complicated sequencing process for getting supplies and materials in and removed materials out. For planning purposes, however, roadway removal involves excavation, transport, disposal of the roadbed material itself (including contouring of the disposed materials), and recontouring or ripping of the underlying floodplain soils. Costs also include construction staking, design, and a contingency to account for any unforeseen construction conditions that may be encountered.

Table 5.3 presents the per-mile and per-acre construction costs for road and railway bed removal. Costs include the cost to excavate, transport, and dispose of the bed material, and to survey and stake the construction area (pre- and post-construction). The costs also include construction mobilization and demobilization costs, design, and contingency, all expressed as a percentage of construction costs. Costs are estimated at $462,000 per mile of roadbed removed, or $127,000 per acre of roadbed surface removed. These costs are based on standard industry practices for developing project planning costs.

Table 5.3. Road and railway bed removal per-unit construction costs[a]

Item	Cost basis	Units included	Cost
Excavating, transporting, and stockpiling bed material	$15.00/cubic yard	1 mile of road bed (bed is 3 feet high, 30 feet wide = 17,600 cubic yards)	$264,000
Construction staking	$3,000/mile	1	$3,000
Construction mobilization and demobilization	3% of construction costs	1	$8,000
Design	20% of construction costs	1	$53,400
Permitting	10% of construction costs	1	$26,700
Contingency for additional site-specific costs	40% of construction costs	1	$107,000
Total	**Per mi of bed removed**		**$462,000**
	Per acre of bed removed[b]		**$127,000**

a. Costs shown include raw materials and labor and equipment costs.
b. The cost per acre is calculated based on removal of 30-foot wide road beds.

5.4 Placer Mine Rehabilitation Construction Costs

Placer mine site rehabilitation construction costs (not including site replanting costs) were derived from a detailed cost analysis presented in a restoration plan for the Sherlock Creek Placer Mine developed for the Forest Service (Maxim Technologies Inc., 2003). The Sherlock Creek Mine is 19.5 acre parcel on the St. Joe waterway where the riparian habitat is currently severely degraded by previous placer mining operations, which included clearing and recontouring of the riparian area and disposal of processed river bottom materials on the land.

The costs in Table 5.4 are based on costs presented in the Sherlock Creek Mine restoration plan (Maxim Technologies Inc., 2003). Costs elements were converted to a per-acre basis. Estimated project costs include costs for engineering design, permitting, and monitoring and maintenance. No contingency is included since the costs in the Sherlock Creek Mine restoration plan are site-specific and therefore already incorporate the substantial site uncertainties that the standard 40% contingency is intended to incorporate. Total cost for these activities at placer mine sites is $89,500 per acre.

Table 5.4. Unit costs for construction activities for placer mine site restoration[a]

Item[b]	Cost	Cost conversion	Cost/acre
Site preparation (mobilization and demobilization, access improvements, structure/equipment removal)	$319,570 (entire project)	Project size: 19.5 ac	$16,400
Site dewatering	$98,393 (entire project)	Project size: 19.5 ac	$5,050
Clear and grub areas (mix of wooded and shrub habitat)	$5,208/ac	-	$5,210
Channel reconstruction	$854,000/ mile	0.0385 miles/ac	$32,800
Engineering design	$197,000 (entire project)	Project size: 19.5 ac	$10,100
Permitting	$110,000 (entire project)	Project size: 19.5 ac	$5,640
Monitoring and maintenance	$278,000 (entire project)	Project size: 19.5 ac	$14,200
Total cost per acre			**$89,500**

a. Costs are based on project costs for the Sherlock Creek Placer Mine (see text). Costs do not include replanting costs.
b. Costs shown include raw materials and labor and equipment costs. Revegetation costs are not included.

5.5 Summary: Replacement Action Costs

Table 5.5 presents a summary of the total per-acre costs of the four replacement alternatives under consideration. Costs range from $3,870 per acre for conservation easement with natural recovery to $221,000 per acre for placer mine rehabilitation.

For conservation easements with natural recovery, the only cost element included is the conservation easement cost. There will be other costs associated with acquiring an easement and ensuring that ecological benefits are derived after the easement is in place, for example, legal and administrative costs associated with the transaction, and site-specific actions that may be required to halt anthropogenic impacts and allow natural recover to begin. Quantification of those costs is ongoing. Currently the price of the easement alone represents a minimum cost for this alternative.

For conservation easements with replanting, the total costs include the cost of the conservation easement and the cost of conducting the vegetation planting. Road and railway bed removal involves only the cost of removing the bed itself; no vegetation planting is included since the roads/railway corridors being removed will generally run through already existing riparian habitat area with ample seed sources and large woody debris. Placer mine rehabilitation costs include the cost of site construction and the cost of replanting.

Table 5.5. Summary of replacement action alternative unit costs, per acre

Replacement action	Conservation easement	Construction	Planting	Total ($/ac)
Conservation easement with natural recovery	$3,870/ac + additional unquantified costs[a]	-	-	At least $3,870
Conservation easement with replanting	$3,870	-	$131,500	$135,000
Road and railway bed removal	-	$127,000	-	$127,000
Placer mine rehabilitation	-	$89,500	$131,500	$221,000

a. Work to quantify additional costs associated with acquisition of a conservation easement with natural recovery is ongoing.

6. Damage Calculations

In this chapter, damages for injured upper basin federal lands are calculated by multiplying the per acre cost of habitat replacement by the number of acres required to restore lost services to baseline and compensate for interim losses. Section 6.1 describes the scaling approach used, and Section 6.2 presents results for the four replacement options.

6.1 Scaling Approach

The determination of the amount of habitat that must be replaced for baseline restoration and compensation for interim losses is termed "scaling." The Trustees used HEA as the scaling tool to determine the appropriate amount of each replacement action required. The scale of replacement actions necessary is calculated such that the habitat service gains obtained over time through habitat replacement exactly offset the habitat service losses over time on the injured lands. Because the timeline of habitat service benefits is different for different habitat replacement actions, the amount of the replacement actions required to offset injury losses varies.

HEA requires inputs on the timeline and severity of injury, and the timeline of habitat services provided by replacement actions. A discount rate of 3% is included to account for the time preference for resources (i.e., resources obtained in the future are valued less than resources obtained in the present) (NOAA, 2000). Table 6.1 presents the HEA inputs used to calculate the injury losses, and Table 6.2 presents the inputs used to calculate the habitat replacement gains for the different replacement activities.

6.2 Results

The results of the HEA calculation are the numbers of acres of each of the replacement actions necessary to restore lost services to baseline and to compensate for interim losses in South Fork Coeur d'Alene River, Canyon Creek, and Ninemile Creek (Table 6.3). More acreage of conservation easements with natural recovery is required than for the three replacement actions that include active restoration of riparian habitat. Natural recovery to baseline conditions will take longer than will restored land recovery; therefore, more acres of natural recovery lands are required to offset the injury losses.

Table 6.1. Inputs for HEA calculation of riparian habitat injury losses

Type of injured parcel	Injured acres by basin: S. Fork Coeur d'Alene River	Canyon Creek	Ninemile Creek	Injury accrual start year	Habitat services in start year (and until increase)	Year service increase begins	Year habitat service reaches 100%[a]
No cleanup action	6.6[b]	53.0	14.9	1981	0%	-[c]	-[c]
Remediated under EPA OU3 ROD	14.6	0	0.7	1981	0%	2013	2052
Remediation completed	30.6	0	0	1981	0%	2001	2040

a. A linear increase in services from 0% to 100% is used for the recovery of injured land.
b. Includes Deadwood Gulch and Government Gulch where OU2 remedial actions were completed but did not restore the riparian zones.
c. No recovery occurs through the last year of calculation, 2110.

Table 6.2. Inputs for HEA calculation of riparian habitat benefits from replacement actions

Replacement action	Year riparian habitat benefits begin[a]	Year benefits reach 100%[b]
Conservation easement with natural recovery	2011	2110
Conservation easement with planting	2011	2050
Road and railroad bed removal	2011	2050
Placer mine restoration	2011	2050

a. For parcels where the replacement actions take place, riparian habitat benefits are 0% before this year.
b. A linear increase in services from 0% to 100% is used for the recovery of all restored land.

Table 6.3. Acres of alternative riparian habitat replacement actions necessary to offset injuries to federal lands

Replacement action	Location/basin of injured lands being offset: S. Fork Coeur d'Alene River	Canyon Creek	Ninemile Creek	Total
Easement with natural recovery	338	461	135	934
Easement with planting	170	232	68	470
Road bed removal	170	232	68	470
Placer mine restoration	170	232	68	470

Table 6.4 presents the costs to conduct each of the scaled replacement alternatives to restore injured resources to baseline and compensate for interim losses in the South Fork Coeur d'Alene River, Canyon Creek, and Ninemile Creek. The costs vary from at least \$3.61 million for conservation easements with natural recovery to \$104 million for placer mine site rehabilitation. The dollar amounts shown in Table 6.4 are the calculated damages for injuries to upper basin federal lands.

Table 6.4. Costs to conduct alternative riparian habitat replacement actions (in millions of 2004 dollars)[a]

	Location/basin of injured lands being addressed			
Replacement action	S. Fork Coeur d'Alene River	Canyon Creek	Ninemile Creek	Total[b]
Easements with natural recovery[c]	At least \$1.31	At least \$1.78	At least \$0.520	At least \$3.61
Easements with planting	\$23.1	\$31.4	\$9.17	\$63.6
Road bed removal	\$21.6	\$29.5	\$8.6	\$59.7
Placer mine restoration	\$37.6	\$51.2	\$15.0	\$104

a. Costs are calculated as the per-acre costs in Chapter 5 multiplied by the acres of each replacement action necessary from Table 6.3.
b. Total may not equal sum of values shown for the three basins because of rounding.
c. Work to quantify additional costs associated with acquisition of a conservation easement with natural recovery is ongoing.

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A. Photos of Injured Upper Coeur d'Alene Basin Federal Lands

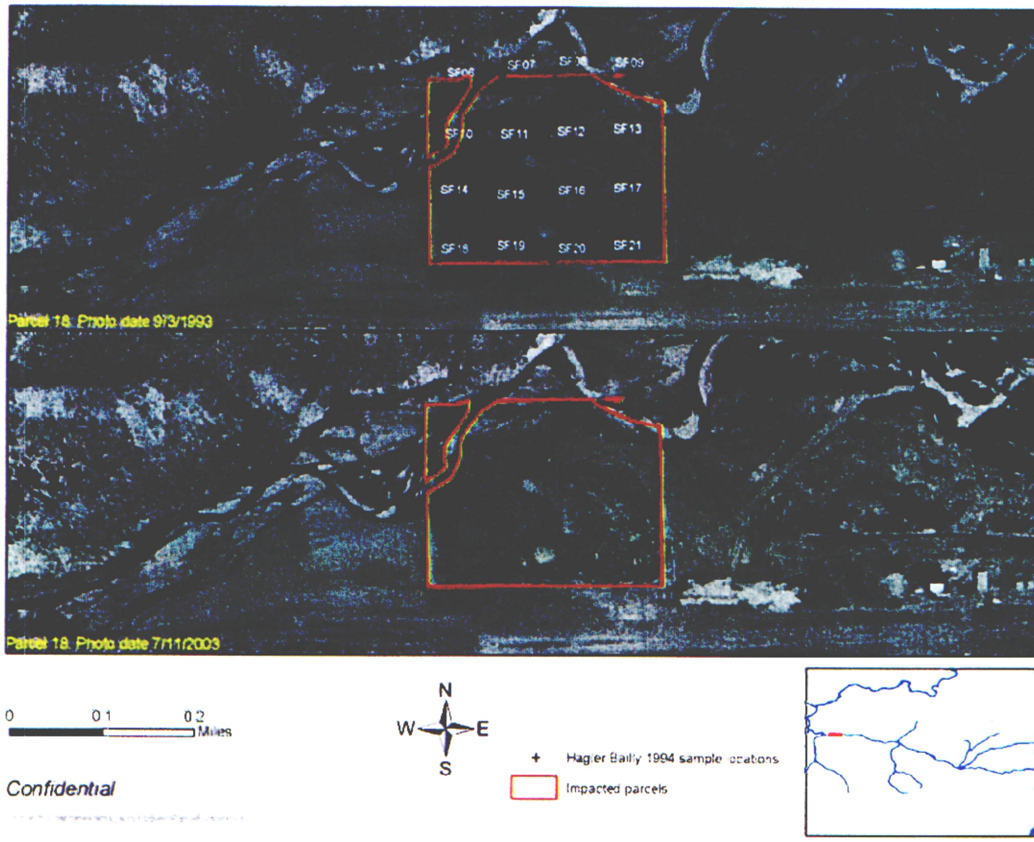

Figure A.1. Smelterville Flats in 1993 and 2003. The area inside the red line (30.6 ac) is administered by U.S. Bureau of Land Management. Response actions at Smelterville Flats in 2000 included removal of 500,000 cubic yards of tailings and contaminated material and initial revegetation. A soil and rock barrier was placed on areas where contaminated material was left in place. Revegetated areas support grasses and cattails. Areas where tailings were not removed support sparse shrubs and a high percentage of bare ground.

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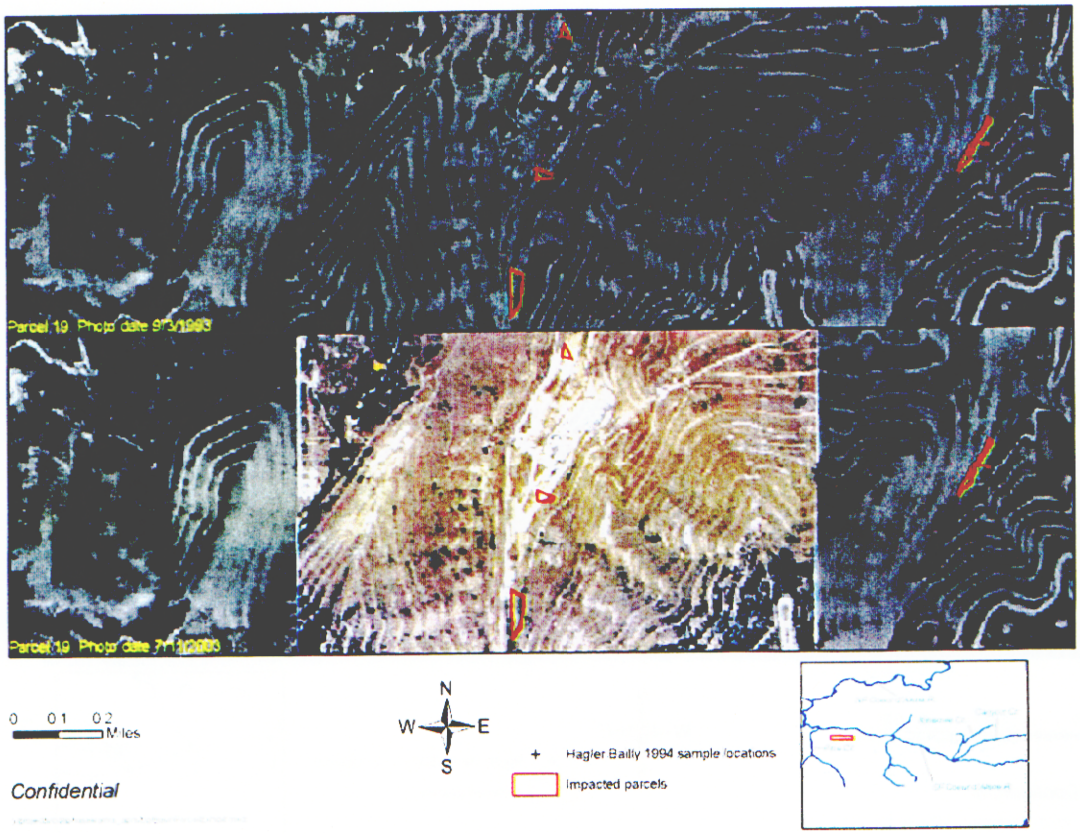

Figure A.2. Injured riparian habitat (1.9 ac) in Government Gulch in 1993 and 2003.

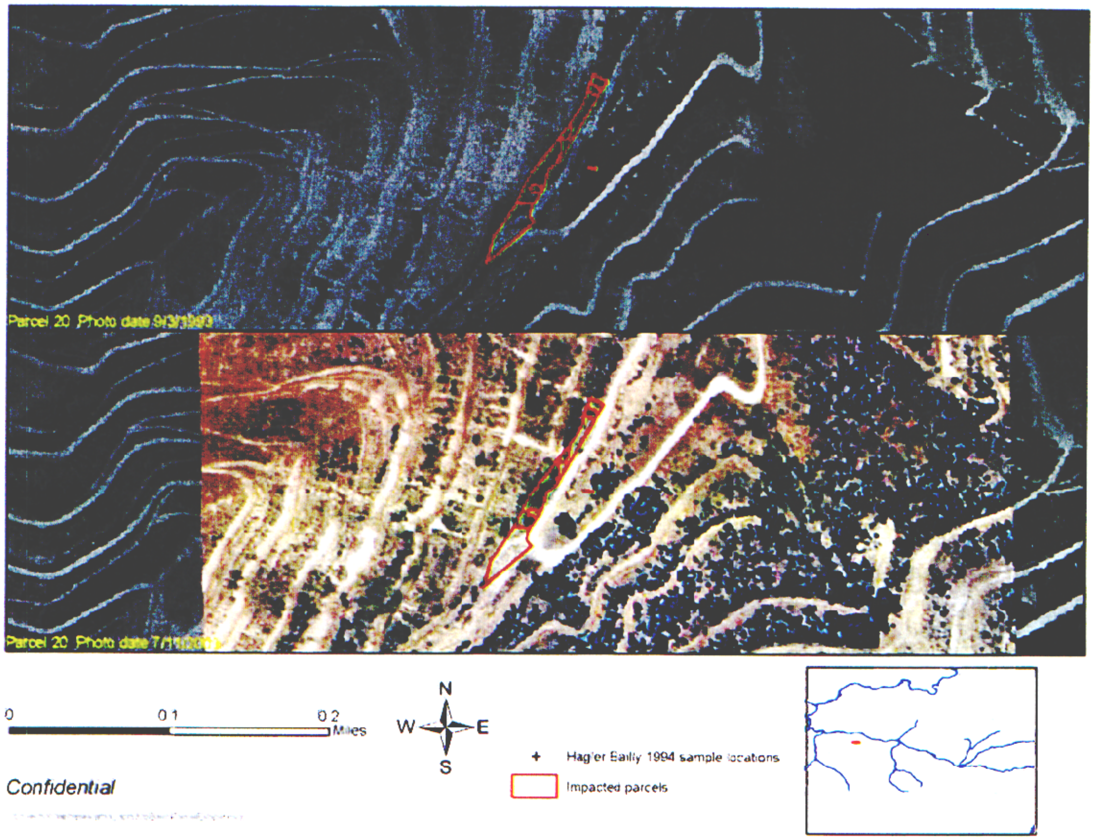

Figure A.3. Injured riparian habitat (0.8 ac) in Deadwood Gulch in 1993 and 2003.

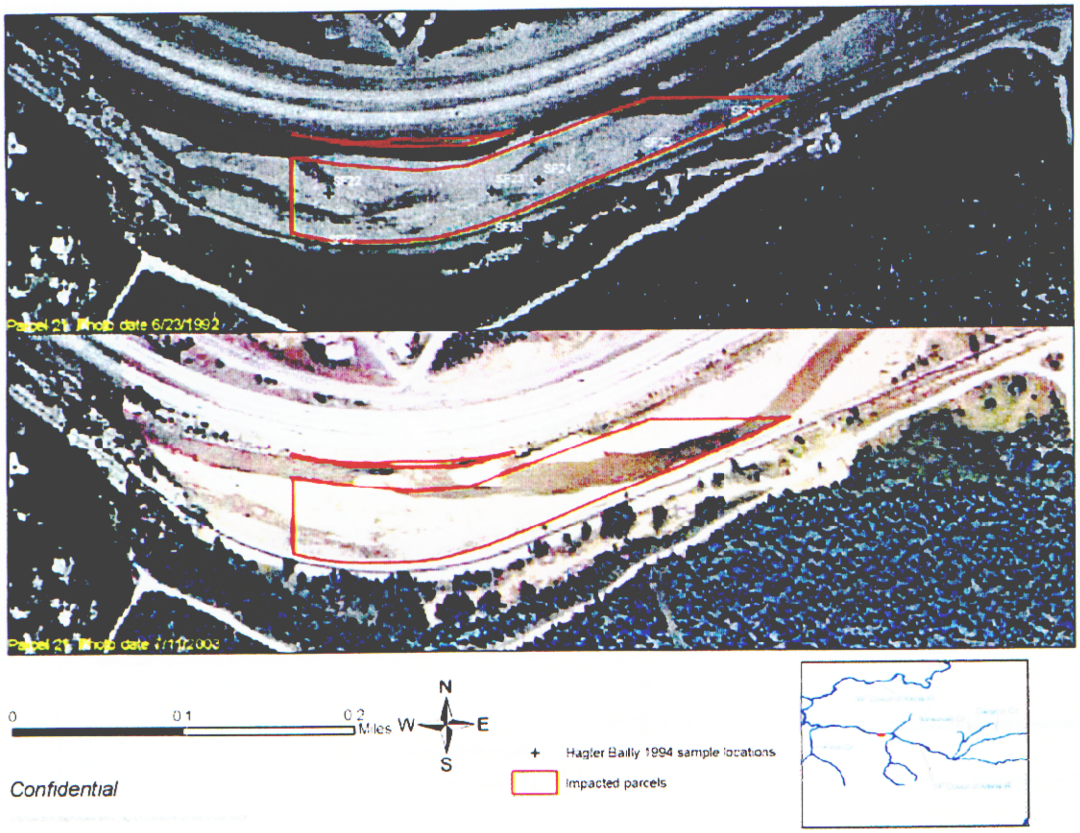

Figure A.4. Injured riparian habitat (6.4 ac) along the South Fork Coeur d'Alene River near Elizabeth Park in 1992 and 2003.

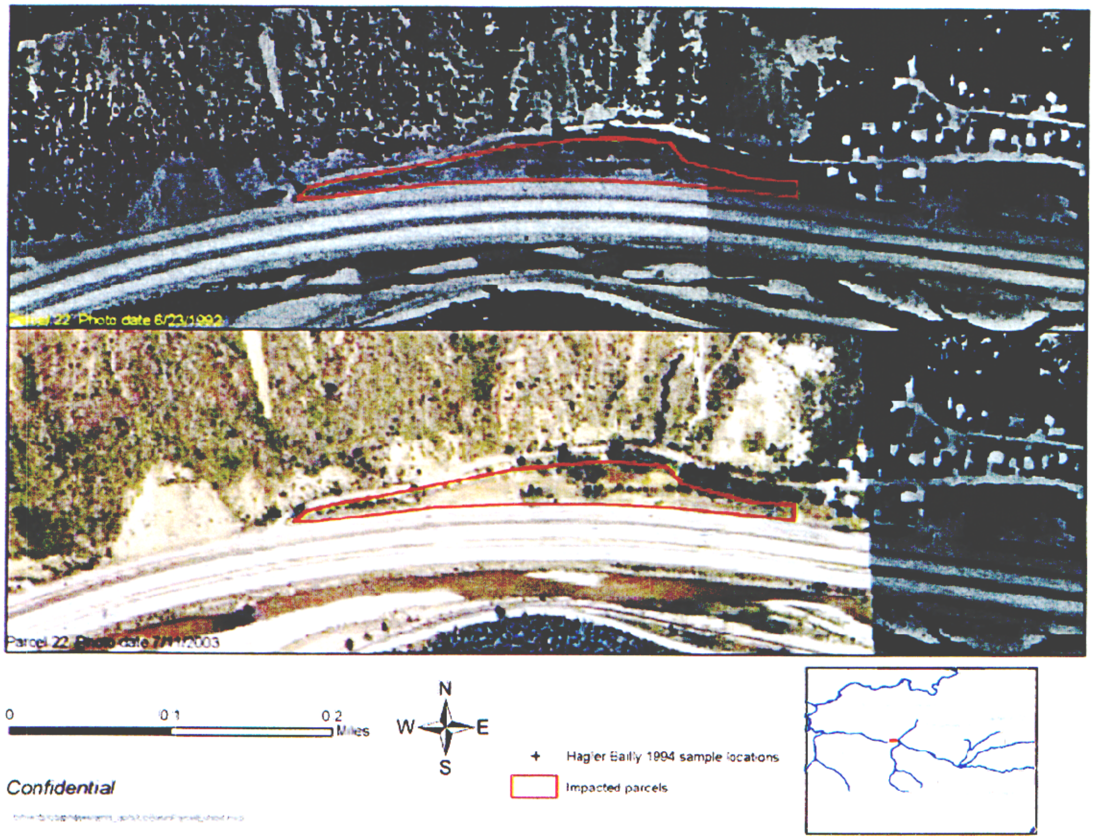

Figure A.5. Injured riparian habitat (3.2 ac) along the South Fork Coeur d'Alene River (north of I-90), downstream of Moon Creek, in 1992 and 2003.

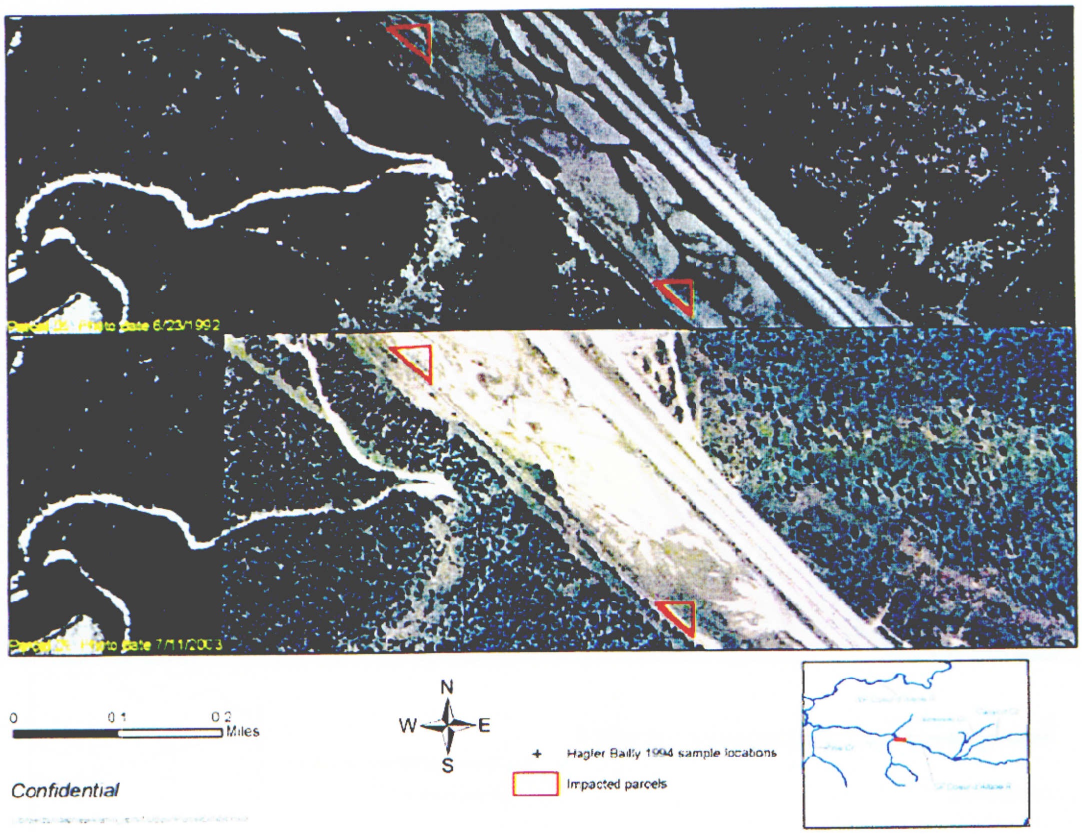

Figure A.6. Injured riparian habitat (6.4 ac) along the South Fork Coeur d'Alene River near Big Creek in 1992 and 2003.

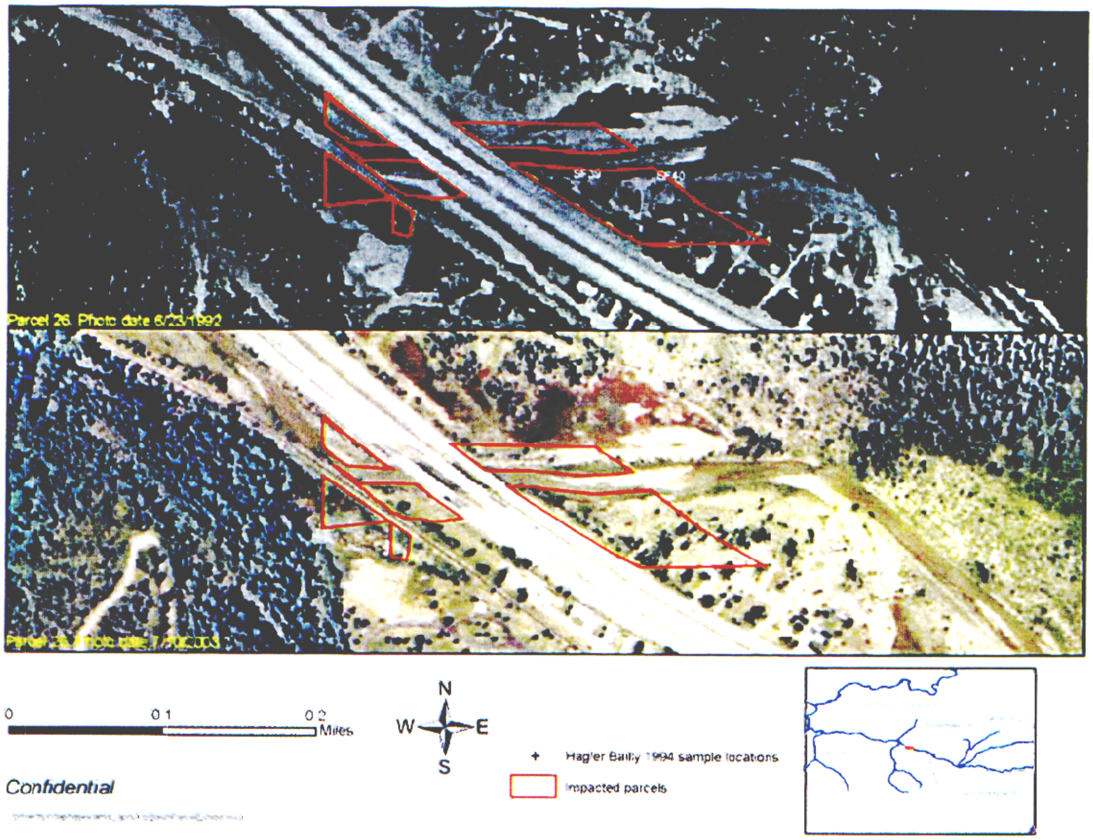

Figure A.7. Injured riparian habitat (5.4 ac) along the South Fork Coeur d'Alene River near Osburn in 1992 and 2003.

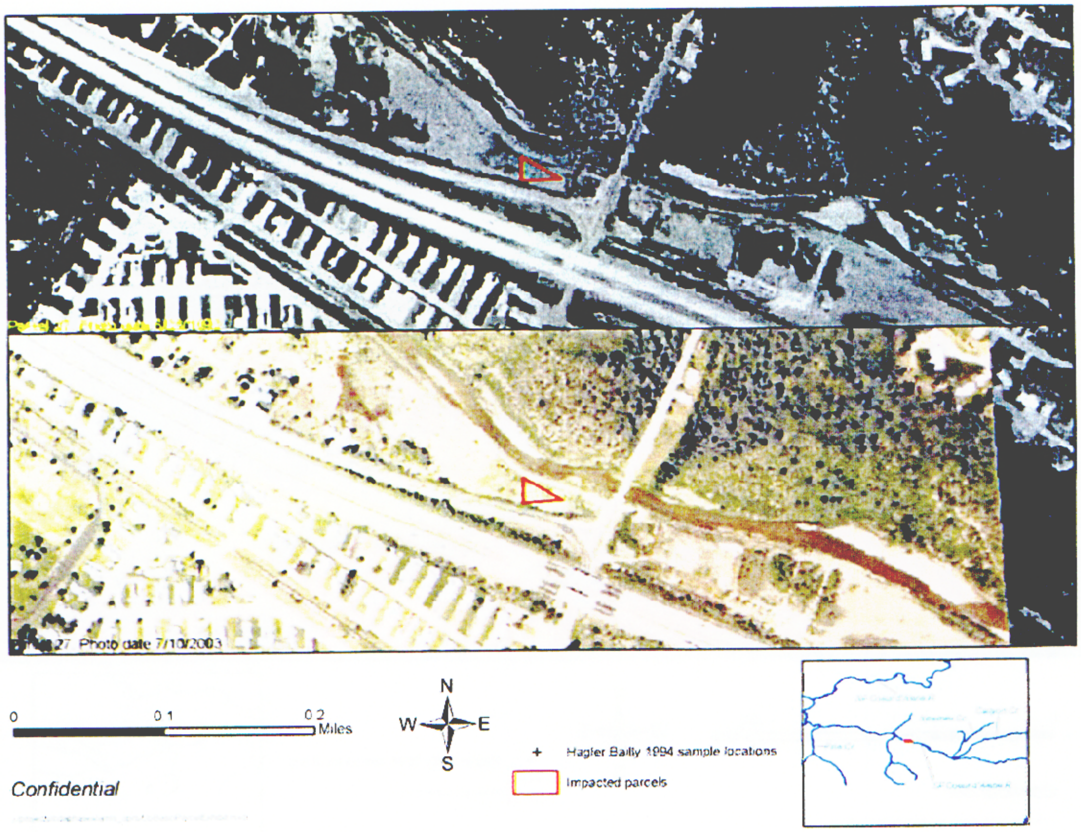

Figure A.8. Injured riparian habitat (0.1 ac) along the South Fork Coeur d'Alene River near Osburn in 1992 and 2003.

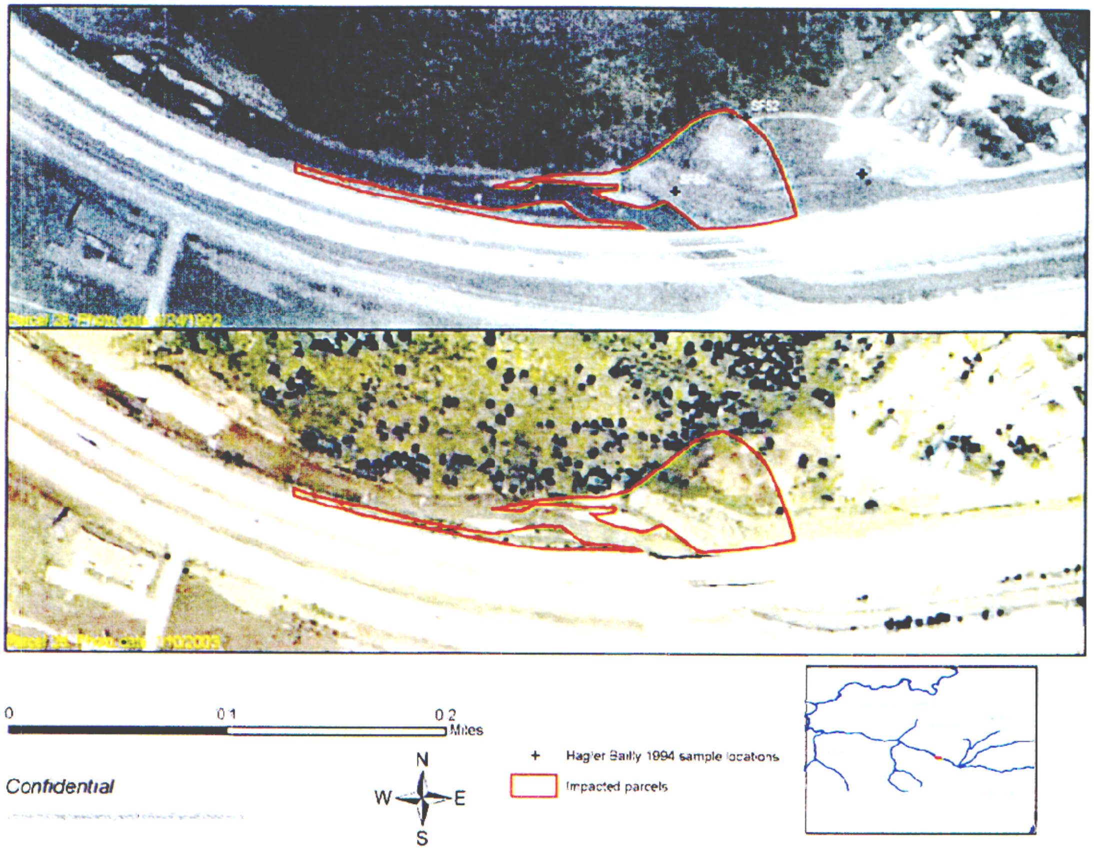

Figure A.9. Injured riparian habitat (2.4 ac) along the South Fork Coeur d'Alene River near Silverton in 1992 and 2003.

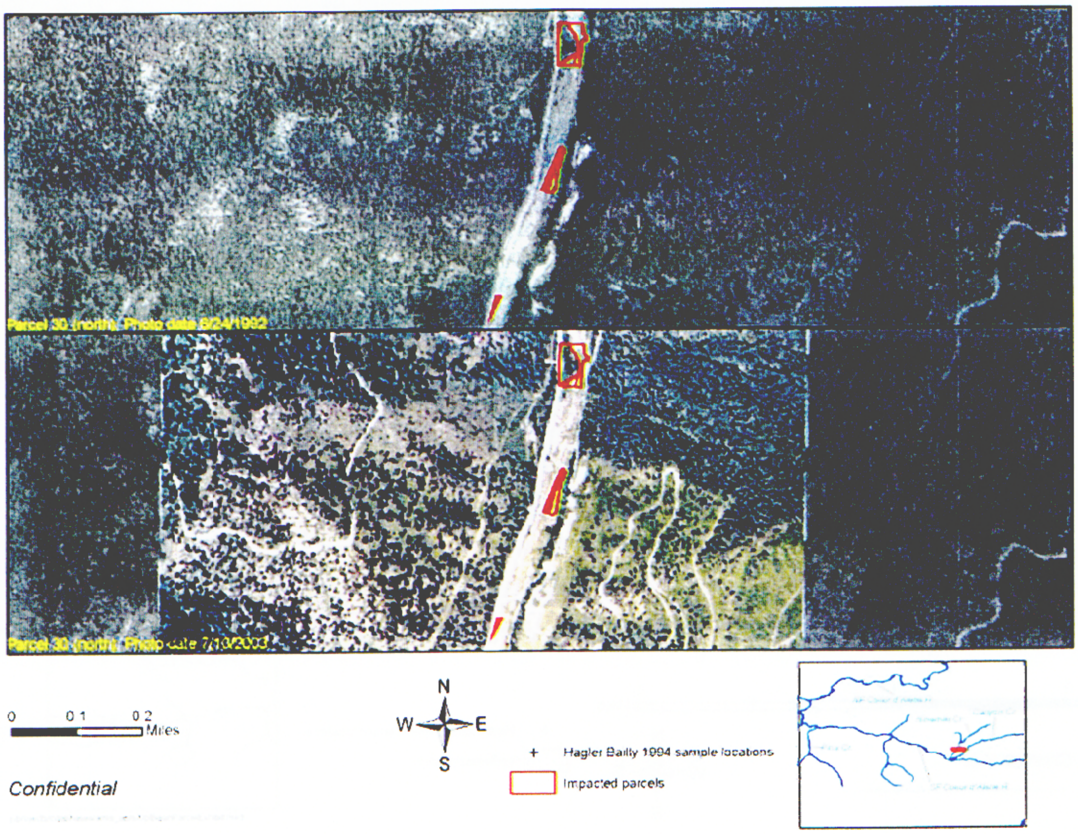

Figure A.10. Injured riparian habitat along Ninemile Creek in 1992 and 2003, northern portion. Injured riparian habitat along the mainstem of Ninemile Creek totals 4.9 ac. This figure shows the northern portion of the 4.9 acres. Figure A.11 shows the southern portion.

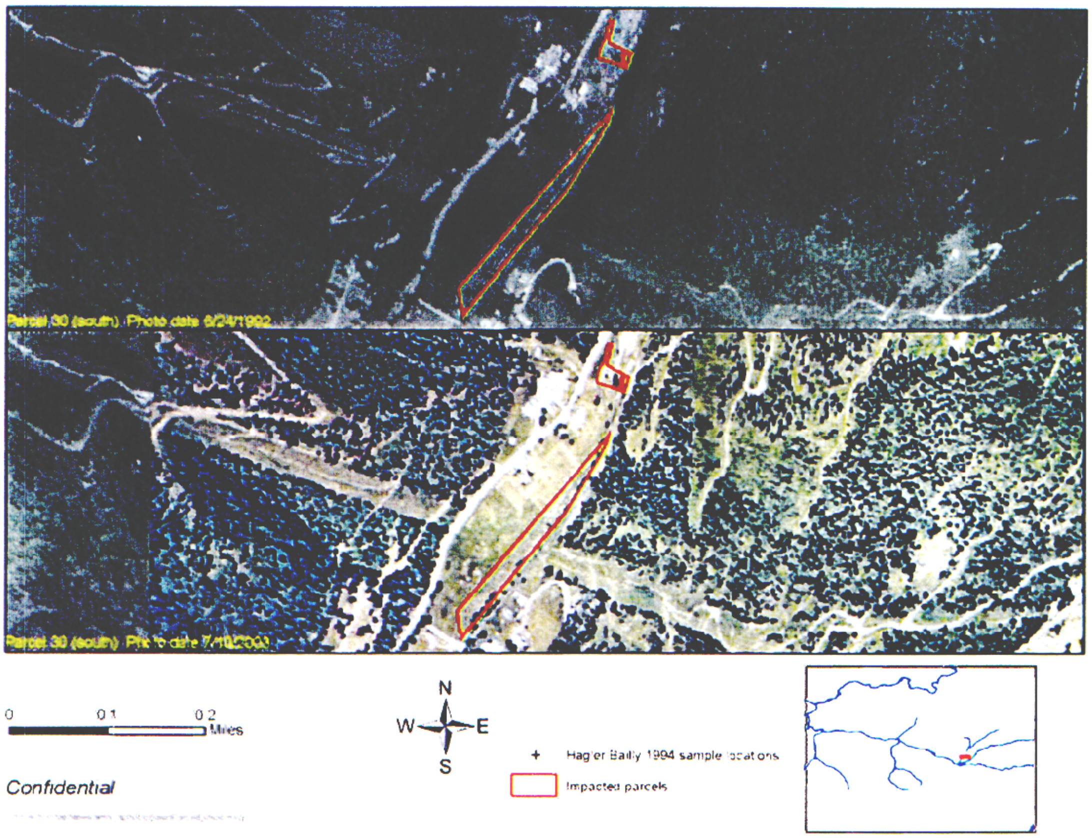

Figure A.11. Injured riparian habitat along Ninemile Creek in 1992 and 2003, southern portion. Injured riparian habitat along the mainstem of Ninemile Creek totals 4.9 ac. This figure shows the southern portion of the 4.9 acres. Figure A.10 shows the northern portion.

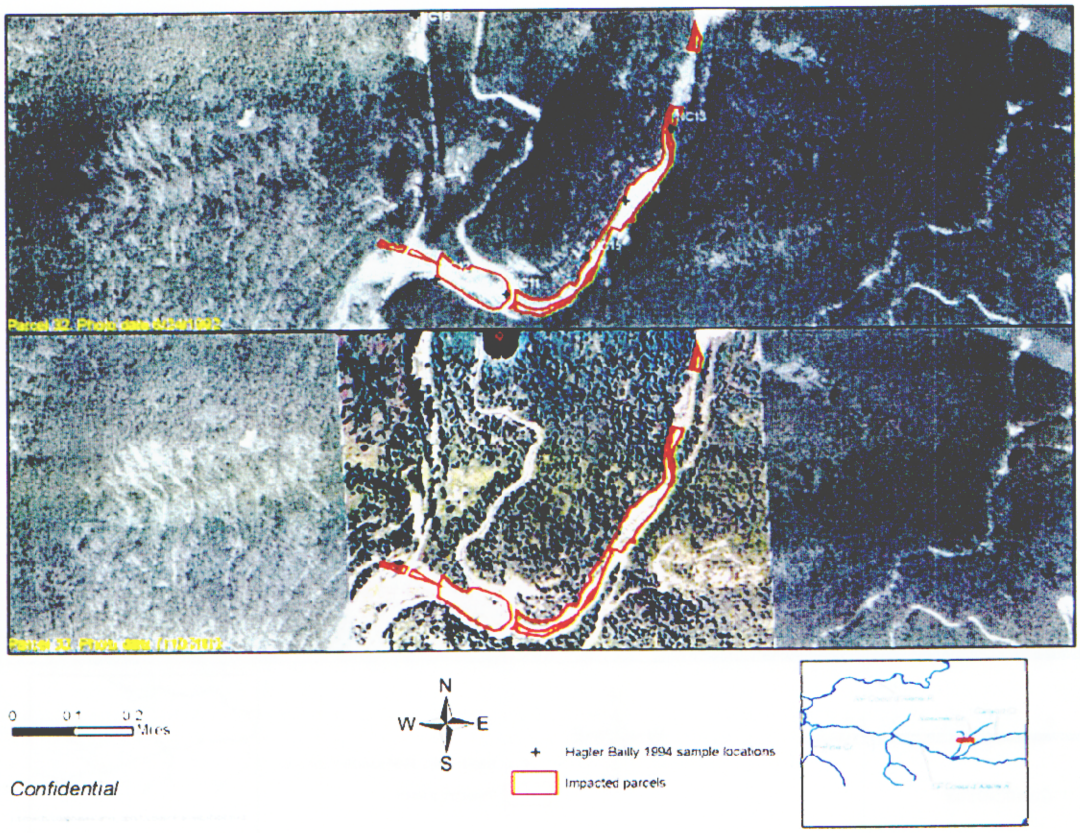

Figure A.12. Injured riparian habitat (10.0 ac) along the East Fork of Ninemile Creek in 1992 and 2003.

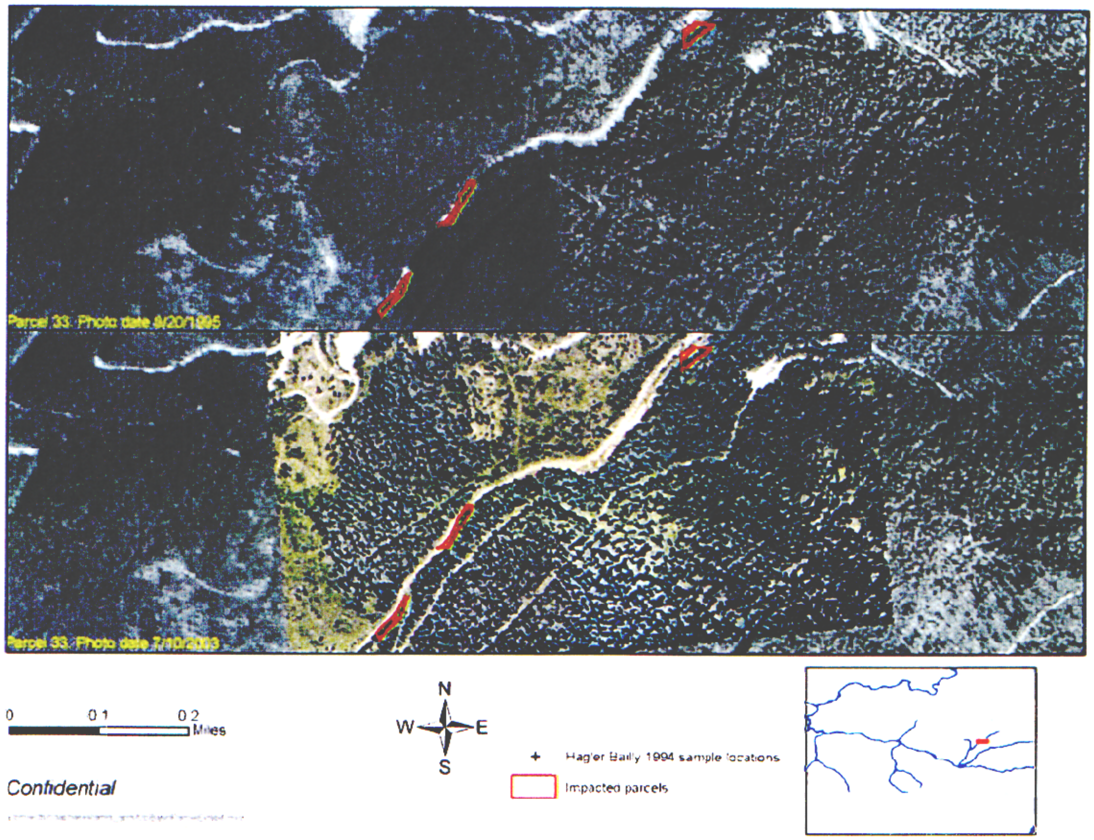

Figure A.13. Injured riparian habitat (0.7 ac) along Canyon Creek upstream of the Success Mine in 1995 and 2003.

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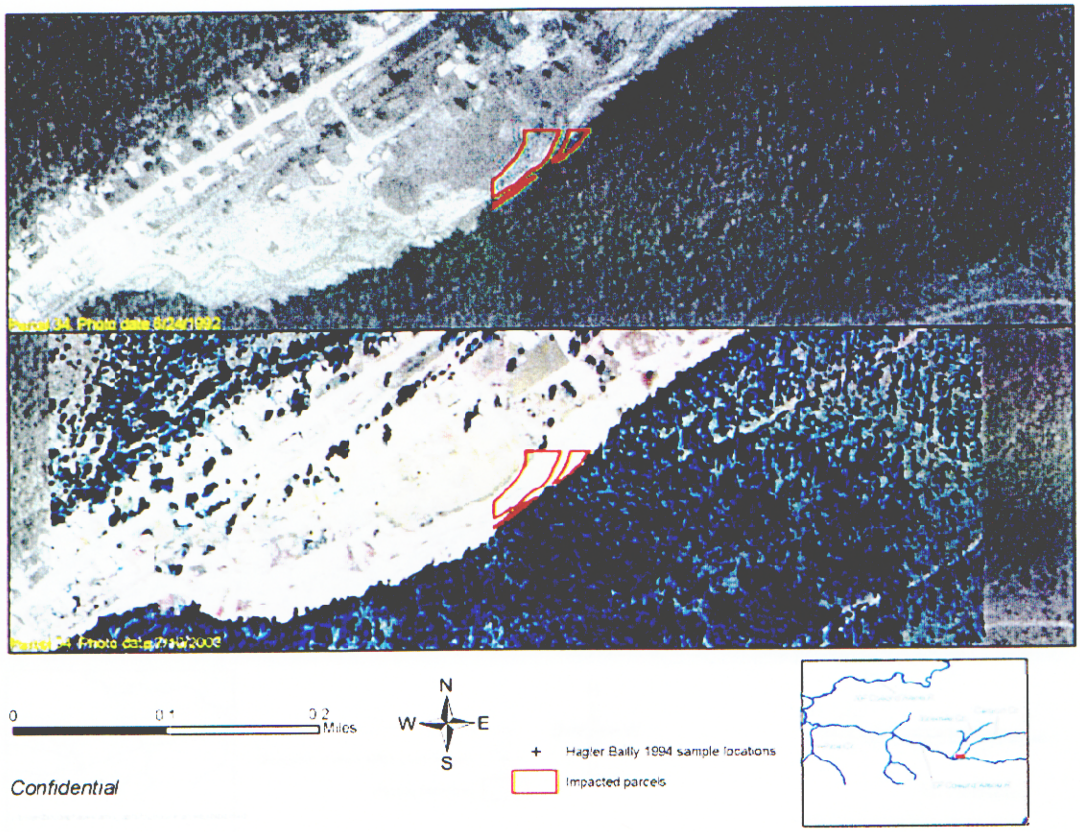

Figure A.14. Injured riparian habitat (0.6 ac) along Canyon Creek downstream of Woodland Park in 1992 and 2003.

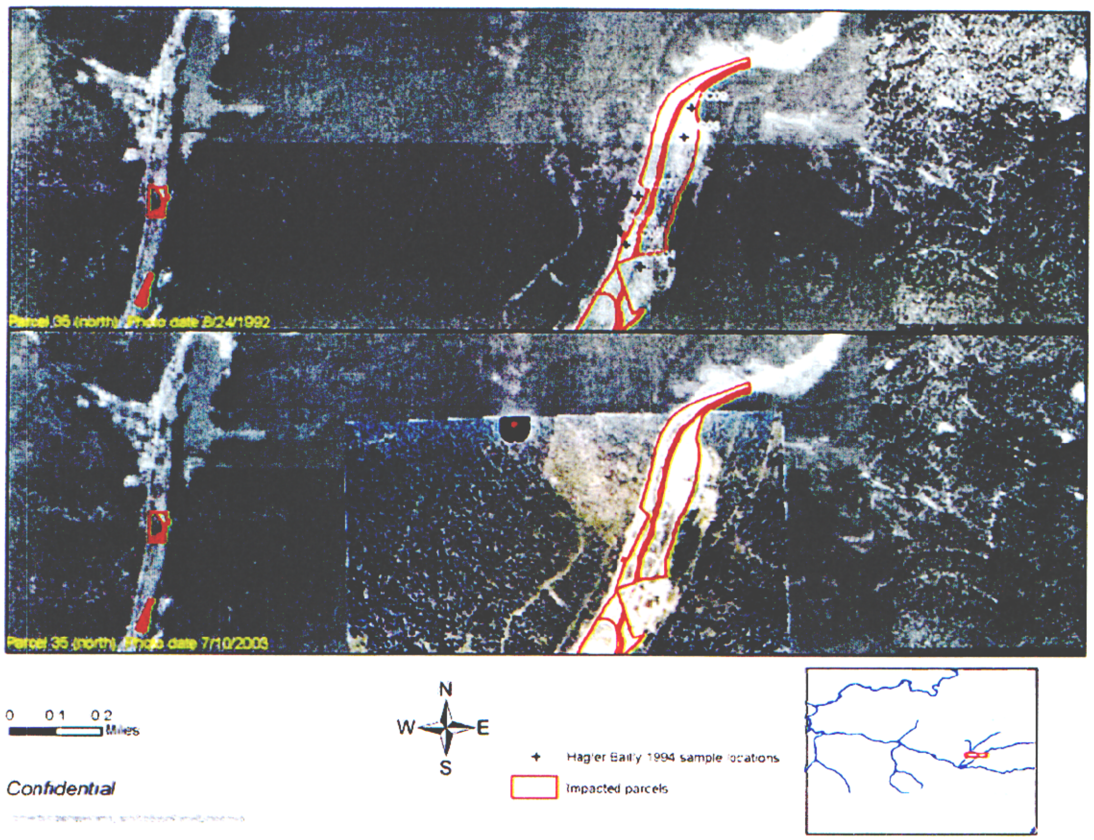

Figure A.15. Injured riparian habitat (51.1 ac) along Canyon Creek upstream of Woodland Park in 1992 and 2003, northern portion. Figure A.16 shows the southern portion.

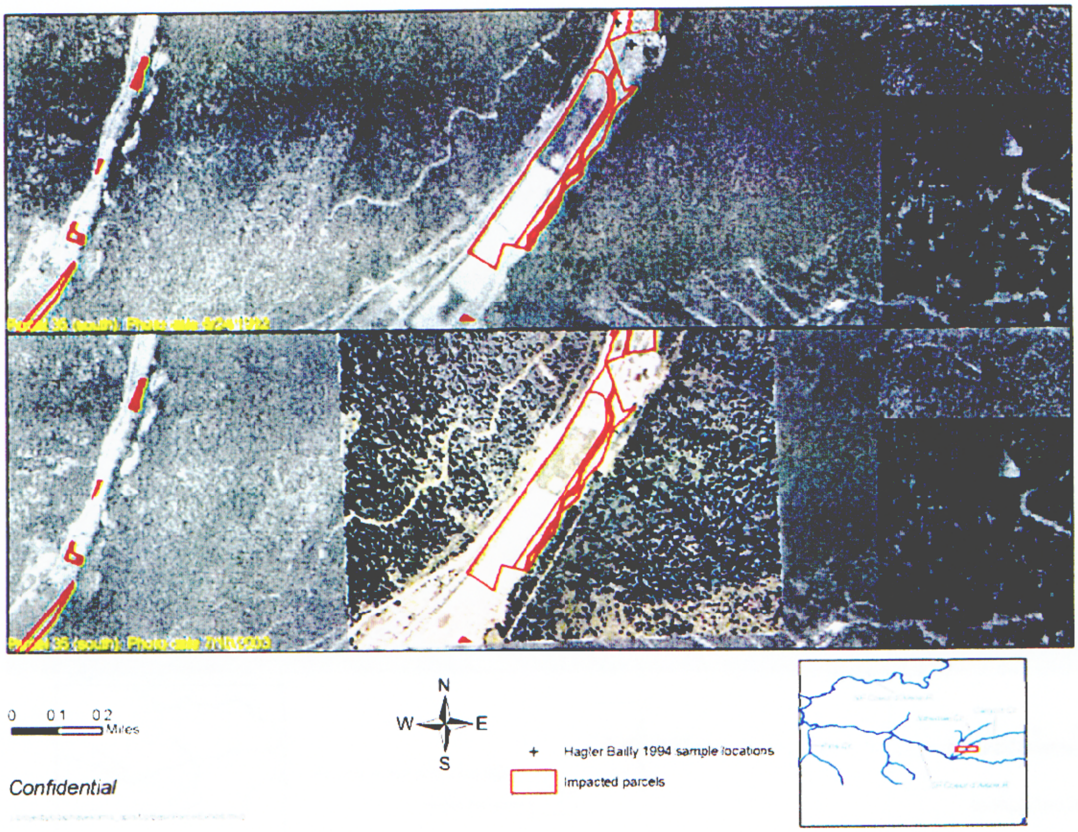

Figure A.16. Injured riparian habitat (51.1 ac) along Canyon Creek upstream of Woodland Park in 1992 and 2003, southern portion. Figure A.15 shows the northern portion.

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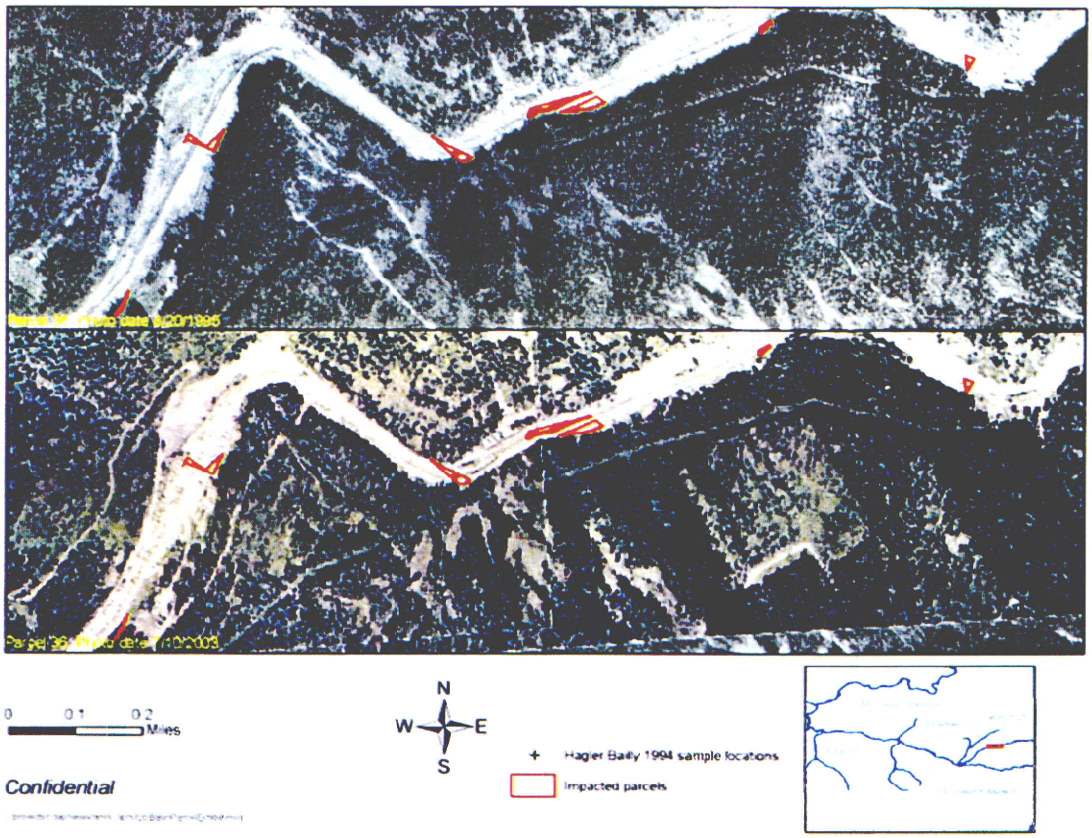

Figure A.17. Injured riparian habitat (1.4 ac) along Canyon Creek near Black Bear and Mace in 1995 and 2003.

Figure A.18. Smelterville Flats, looking south across the South Fork Coeur d'Alene River at lands administered by the U.S. Bureau of Land Management. Photo date: August 14, 2004.

Figure A.19. Smelterville Flats, looking south at lands administered by the U.S. Bureau of Land Management and remediated in 2000. Photo date: August 14, 2004.

Figure A.20. Another view of Smelterville Flats, looking south at lands administered by the U.S. Bureau of Land Management and remediated in 2000. Photo date: August 14, 2004.

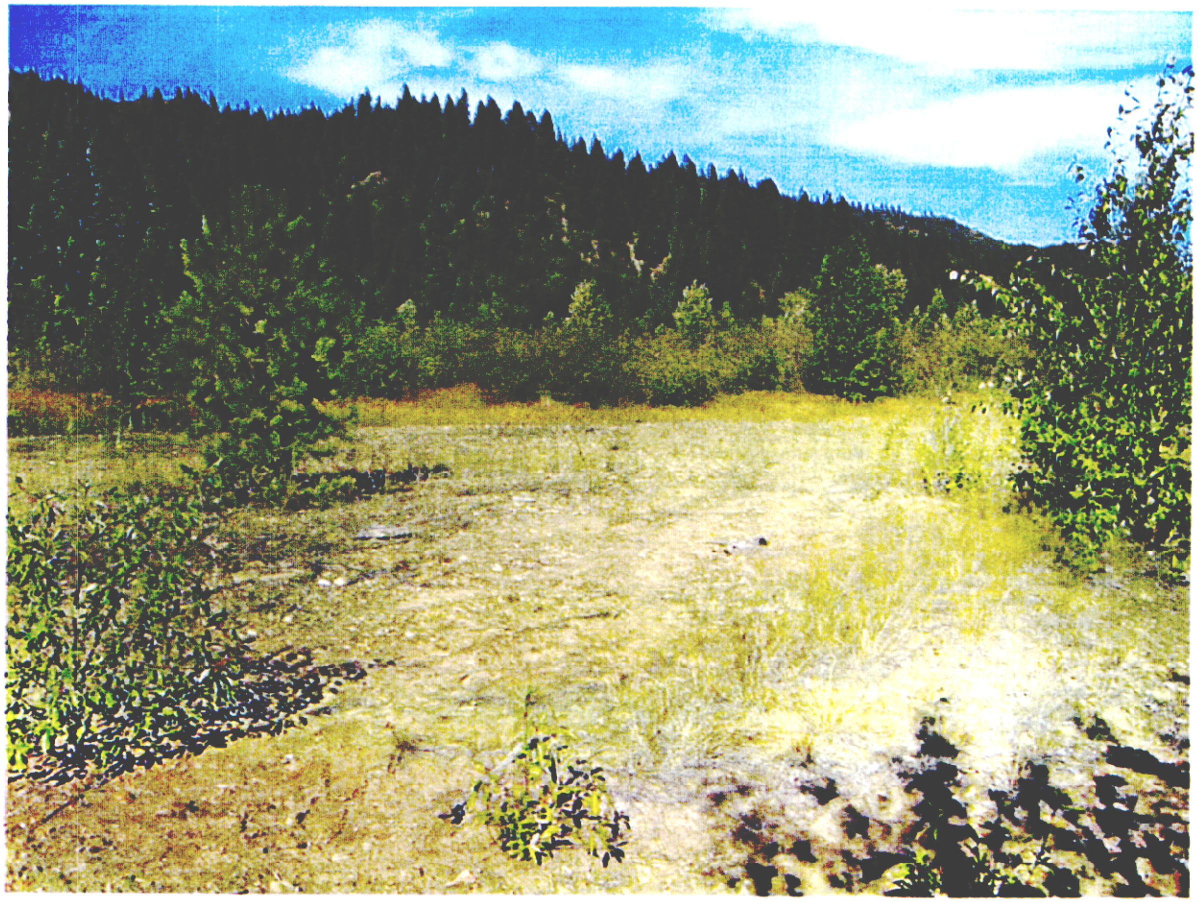

Figure A.21. Smelterville Flats, area of Smelterville Flats where tailings and contaminated soil were not removed as part of the remedy. Photo date: August 14, 2004.

Figure A.22. South Fork Coeur d'Alene River floodplain near Elizabeth Park, and assessment sites SF22 through SF28, sampled in 1994. Photo date: August 14, 2004.

Figure A.23. South Fork Coeur d'Alene River floodplain near Osburn, and assessment sites SF39 and SF40, sampled in 1994. Looking south across the South Fork Coeur d'Alene River. Photo date: August 14, 2004.

Figure A.24. East Fork of Ninemile Creek floodplain downstream of the Success tailings. Removal and revegetation actions were conducted in 1995-1996. Photo date: August 14, 2004.

Figure A.25. East Fork of Ninemile Creek floodplain, looking upstream toward the Success tailings. Assessment sites sampled in 1994 were in this reach. Removal and revegetation actions were conducted in 1995-1996. Photo date: August 14, 2004.

Figure A.26. East Fork of Ninemile Creek floodplain, looking downstream. Assessment sites sampled in 1994 were in this reach. Removal and revegetation actions were conducted in 1995-1996. Photo date: August 14, 2004.

Figure A.27. East Fork of Ninemile Creek floodplain, looking upstream from the confluence of the East Fork and mainstem Ninemile Creek. Removal and revegetation actions were conducted in 1995-1996. Assessment sites sampled in 1994 were in this reach. Photo date: August 14, 2004.

Figure A.28. Canyon Creek floodplain looking upstream from Woodland Park. Removal and revegetation actions were conducted in 1995-1996. Photo date: August 14, 2004.

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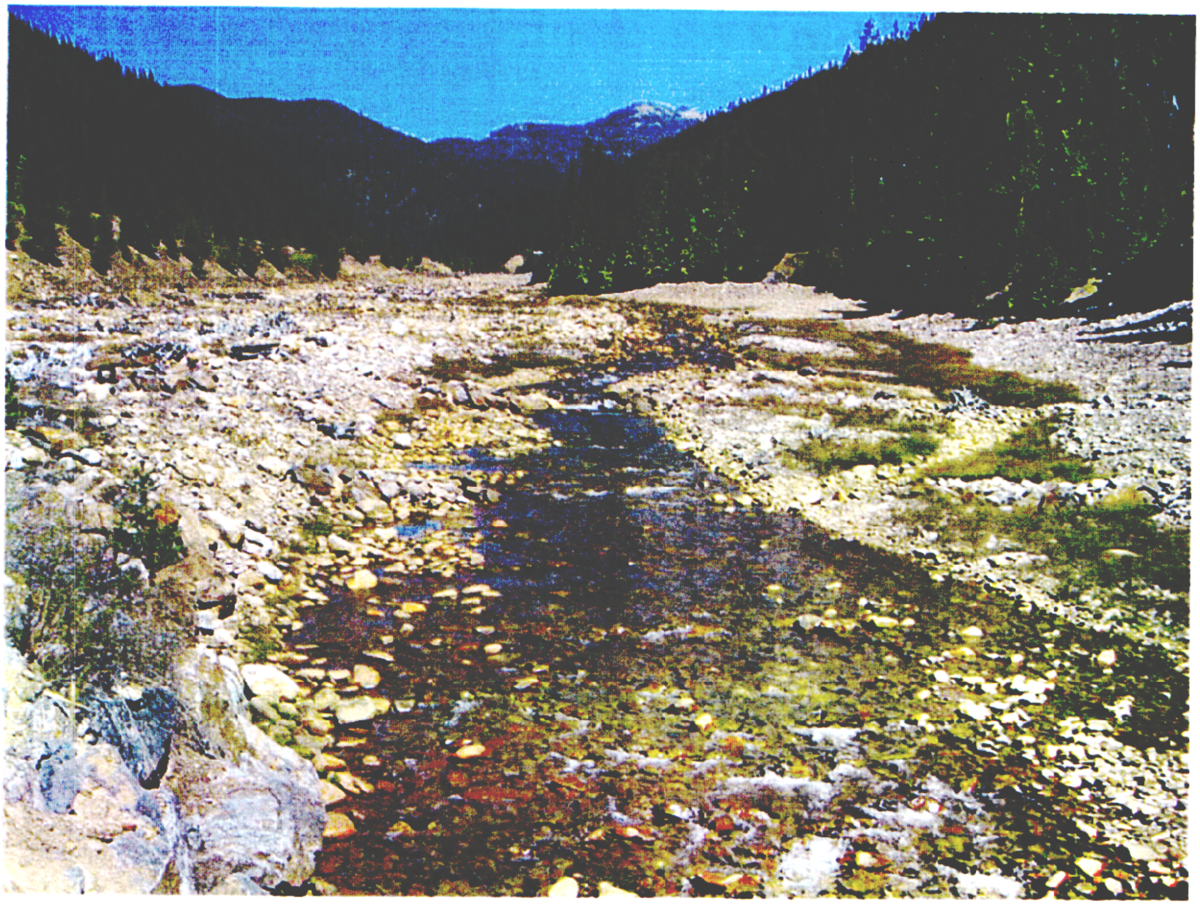

Figure A.29. Canyon Creek floodplain looking upstream from the Star Tailings. Assessment sites sampled in 1994 were in this reach. Removal and revegetation actions were conducted in 1995-1996. Photo date: August 14, 2004.

Figure A.30. Canyon Creek floodplain looking upstream from the Star Tailings. Assessment sites sampled in 1994 were in this reach. Removal and revegetation actions were conducted in 1995-1996. Photo date: August 14, 2004.

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B. Cost of Land Acquisition and Easements

This appendix develops an estimated cost to purchase or obtain easements on lands similar to the types of federal land that have been contaminated by mining activities in the Coeur d'Alene River basin. The federal lands of concern in the lower basin are mainly agricultural, palustrine, and riparian types of habitat. The federal lands of concern in the upper basin are riparian lands along rivers and creeks.

In developing the cost for land acquisition or easements, we followed the appraisal industry standards for appraising land values. We did not conduct complete appraisals for specific properties because specific properties for acquisition or easements have not been identified by the Trustees. However, the basic characteristics of the properties of interest have been identified. For the Lower Coeur d'Alene basin these property characteristics are agricultural lands proximate to a water source that could be converted into tundra swan habitat. For the upper Coeur d'Alene River basin lands, the characteristics are riparian zone lands that can be converted to high quality riparian habitat or protected through easements from loss of habitat. The purpose of this appendix is to develop approximate values of these types of land and associated easements.

There are variants on the specific definition of value used by land appraisers, however, the commonly cited definition from the 1995 Edition of the Uniform Appraisal Standards for Federal Land Acquisitions (Appraisal Institute, 1995) defines value as:

> The amount in cash, or on terms reasonable equivalent to cash, for which in all probability the property would be sold by a knowledgeable owner willing but not obligated to sell to a knowledgeable purchaser who desired but is not obligated to buy.

In general, a property appraisal can involve three approaches: the sales comparison approach, the cost approach, and the income approach. However it is not uncommon for appraisals to be based solely on the sales comparison approach. In this area, the market for rural property with nonagricultural and recreational attributes is not solely motivated by any potential earning capacity of the property. The market is driven by aesthetics, recreational opportunities, income tax benefits, wildlife protection and enhancement, and the potential for value appreciation (Norman C. Wheeler and Associates, 2000c). Our overall approach to estimating property values used the sales comparison approach.

Finally, as stated above, persons knowledgeable of local appraisals and conservation easements were contacted to confirm our approach to evaluating property values and to help understand specific issues with conservation easements in the region.[2]

The rest of this report is organized of follows. Section B.1 presents estimates of the cost to purchase land in the lower Coeur d'Alene basin and the cost to obtain conservation easements on lower basin lands. Section B.2 presents estimates of the cost to purchase riparian lands in the upper basin and the cost to purchase conservation easements for upper basin lands. Section B.3 summarizes the results.

B.1 Costs of Land Acquisition in Lower Coeur d'Alene River Basin

We used recent sales data for properties comparable to the federal lands in the lower basin such as agricultural and palustrine lands that could be converted to tundra swan habitat. Priority was given to areas defined as lands within the 500-year floodplain. Figure B.1 identifies the locations of the properties used for comparison.

From the evaluation dataset we developed selection criteria for comparable sales: 1) sales with an agricultural use, and 2) no smaller than 10 acre lots. Smaller lots were eliminated for two reasons. First, the types of lands the Trustees are most interested in are larger lots in the 100-200 acre range. Second, the average per acre costs of smaller lots, below 10 acres or so, are usually much higher than the average per acre costs of larger parcels of land. Using these selection criteria, we identified 40 sales transactions from the evaluation dataset that provided reasonable estimates of the cost to purchase lands with the necessary characteristics. In addition, we included two properties from the MLS dataset. Thus, in total we used 42 properties to construct the overall set of information to develop the land price estimates.

Because we did not identify any specific property to purchase, a complete appraisal approach to estimating the market value of specific properties was not appropriate. Instead, we evaluated the available data to develop a reasonable estimate of the cost to purchase lands of the type necessary by using multiple land types in a wide area in the region. Limiting the evaluation to an area around the Coeur d'Alene basin allowed us to develop a range of costs to purchase similar lands.

2. Appraisers were Stacey Stoval of Conservation Innovations, Inc. in Laclede, Idaho, and Sandy Emerson of Emerson Valuation in Coeur d'Alene.

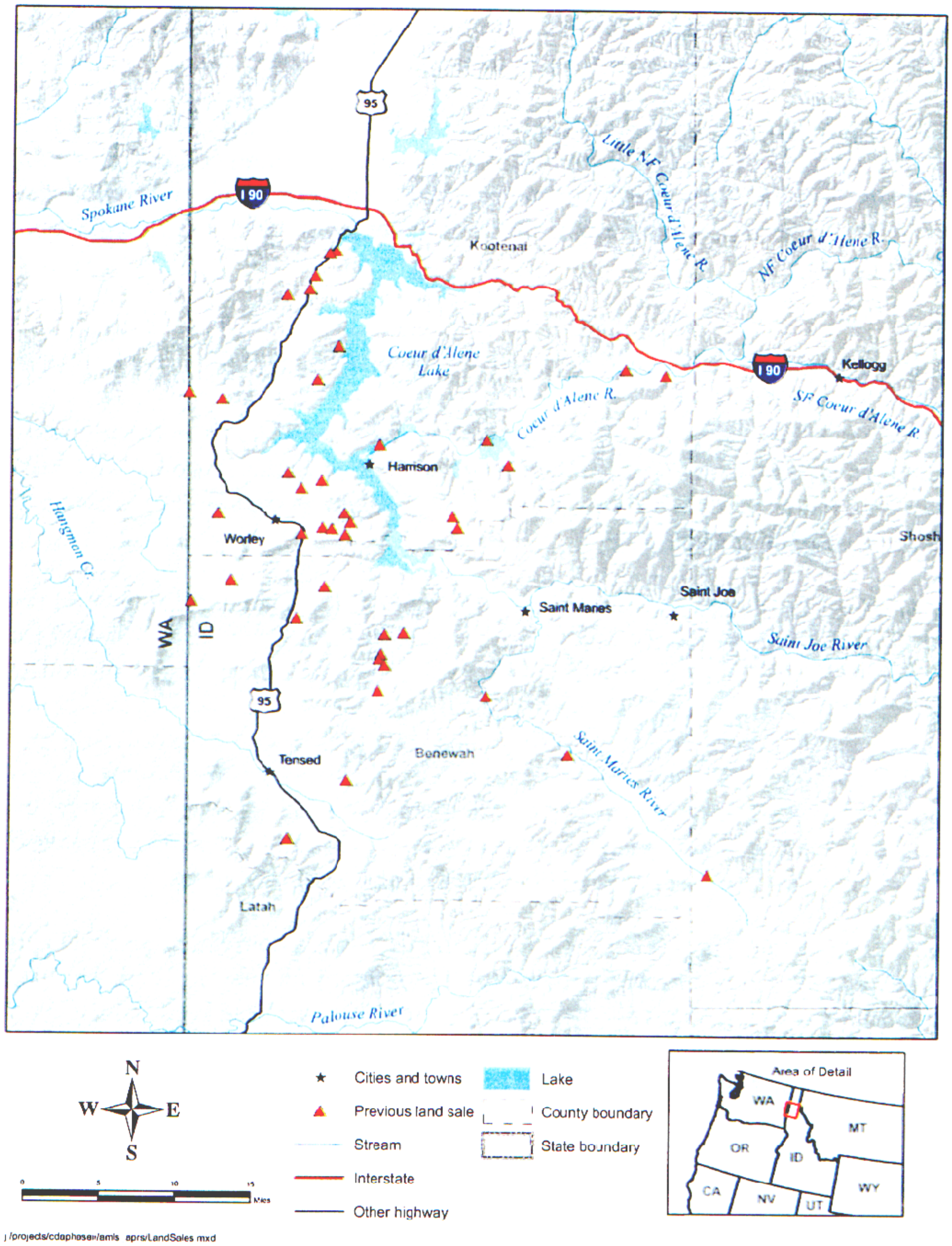

Figure B.1. Approximate location of referenced appraisal properties.

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Our evaluation of the 42 identified properties in the area that are representative of the types of lands of interest to the Trustees produced a simple average price of $1,510 per acre and a weighted average price (where per acre price is weighted by the size of the transaction) of $1,384. Prices ranged from a low of $325 per acre to a high of $3,791 per acre. The property size averaged 189 acres and ranged from 22 acres to 802 acres. The transactions took place between 1993 and 2004 (Table B.1) and Figure B.1.

Table B.1. Summary of larger land transactions in Coeur d'Alene area during 1993-2001

Type of land	Number of transactions	Average number of acres per transaction	Price per acre
Pastureland, meadow, or grazing lands	11	168	$1,499
Agricultural land or cropland	15	255	$1,111
Timberland or upland	15	145	$1,998
Wetlands	1	92	$325
Total	42	189 (average)	$1,510 (average) $1,384 (weighted average)

B.1.1 Available properties (June 2004)

In addition, three additional properties were identified that were recently sold or currently available properties. During June 2004, three large properties (each over 300 acres) were for sale near the town of St. Maries (Table B.2). The average price per acre for these properties is $1,360. Prices ranged from $1,100 to $2,000 per acre. Brief descriptions of the properties follow:

- 550 acres in the St. Joe watershed, about 8 miles north of St. Maries, in the mountains. The listed sale price is $1,006,700 ($1,830 per acre). The property is also available for sale in three separate pieces:
  - 210 acres with a large pond for $430,000 ($2,050 per acre)
  - 180 acres for $280,000 ($1,560 per acre)
  - 160 acres for $297,000 ($1,860 per acre).
- 880 acres east of Plummer (between Plummer and St. Maries). The property includes a perennial creek, timber, big game, and upland birds. It does not currently have zoning restrictions. The listed sale price is $965,000 ($1,100 per acre).

Table B.2. Summary of property listings in St. Joe area in June 2004

Location	Acres	Type of land	Price per acre
St. Maries	550	Pastureland and timberland	$1,830
Plummer	880	Timberland	$1,100
Tensed	345	Cropland and timberland	$1,280
Average	592		$1,403 (average) $1,361 (weighted avg.)

- 345 acres, zoned agricultural, east of Tensed (east of St. Maries). Some of the land is contracted to participate in the USDA's Conservation Reserve Program (CRP) until 2011. The program compensates landowners to conserve resources on their land and can restrict activities permitted on the land. The property includes a seasonal creek and light timber. The listed sale price is $441,500 ($1,280 per acre).

For the lower basin lands under consideration, a reasonable estimate of the an average price per acre to purchase lands would be in the $1,300 to $1,500 range. Figure B.2 shows the approximate location of these properties.

B.1.2 Conservation easements

The USDA operates the WRP, which offers landowners lump sum or annual payments in exchange for providing the USDA with a long-term easement on the property to create or restore wetlands. The length of the easement is either for 30 years or in perpetuity. The payment amount is the lesser of the appraised value of the property or the $1,500 per acre program cap.

There are currently two WRP easements in the St. Joe area, and a third easement is in the planning stages. All three easements are perpetual. The USDA is responsible for initial restoration costs on all of these properties, but landowners are responsible for maintenance costs. Details specific to each of the appraisals conducted in developing the easement payments are described below.[3]

3. There are a number of common properties identified across the three easement appraisal reports. Of the 39 properties identified in the three appraisals, there are only 26 unique properties that are used in developing the overall averages and range.

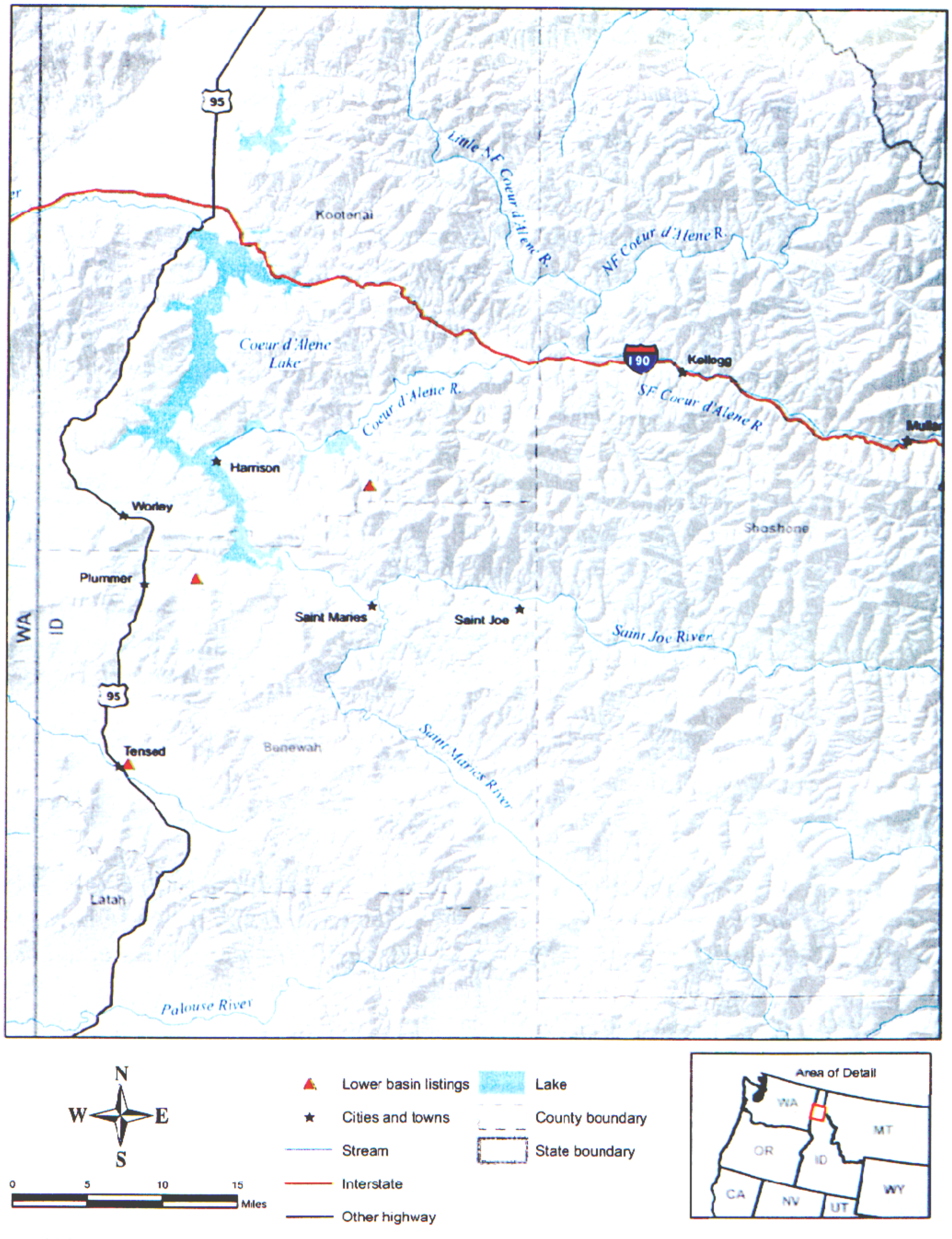

Figure B.2. Approximate locations of lower basin available land sites.

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Hepton easement

The Hepton is the largest WRP easement in the St. Joe area, at 1,143 acres. The USDA bought the easement after a dike was breached on the property. There has been natural regeneration on the property following the dike breach, and restoration costs have been minimal (approximately $12,000, or approximately $11 per acre). The largest cost was for a water control structure.

Nineteen comparable sales transactions were used in the appraisal to obtain property values. The average price for pasture/hay ground was $850 per acre, for irrigated cropland $1,500 per acre, and for timberland $1,250 per acre (Table B.3). Based on the appraisals, the 1,143 acres of the Hepton property appraised at $1,630,000, or $1,426 per acre.

Table B.3. Summary of property transactions used in the Hepton WRP easement appraisal in the St. Joe River area, 1994-1997

Type of Land[a]	Number of transactions	Average number of acres per transaction	Price per acre
Pastureland	4	59	$1,224
Timberland	7	29	$1,721
Cropland	8	76	$1,681
Total	19	40 (average)	$1,600 (average) $1,588 (weighted average)

a. Type of land category reflects primary use of land.

Fish easement

This easement covers 40 acres of land previously used for hay production. The USDA incurred minimal costs for restoration on this property because a Superfund site in need of clean soil paid for the excavation. Costs incurred by the USDA were primarily for a cross fence, at a cost of $2 per linear foot.

The property was appraised at $800 per acre for the 40 acres of pastureland. Thirteen comparable sales transactions between 1994 and 1997 were used to estimate the value (Table B.4). Prices reflected a range of property types and ranged from $325 per acre to $2,400 per acre. The average prices per acre were $1,514 for pastureland, $1,423 for timberland, and $1,439 for cropland.

Table B.4. Summary of property transactions used in the Fish WRP easement appraisal in the St. Joe River area during 1994-1997

Type of land[a]	Number of transactions	Average number of acres per transaction	Price per acre
Pastureland	4	70	$1,514
Timberland	6	30	$1,423
Cropland	2	53	$1,439
Wetlands	1	92	$325
Total	13	51 (average)	$1,369 (average) $1,168 (weighted average)

a. Type of land category reflects primary use of land.

LaBoure easement (transaction not completed as of July 22, 2004)

This proposed 28 acre easement is for land located near Houser Lake previously used for hay production. The only USDA-incurred cost for developing this wetland restoration will be for planting. A contractor has agreed to excavate the wetland at no charge in exchange for rights to sell the soil.

The property was appraised for $27,300, or $975 per acre. Data from seven transactions between 1997 and 2000 were used in the appraisal (Table B.5). Prices ranged from $682 per acre to $1,096 per acre. The average per acre prices were $752 for pastureland and $975 for cropland, averaging $911 per acre.

Table B.5. Summary of property transactions used in the LaBoure WRP easement appraisal in the St. Joe River area during 1997-2000

Type of land[a]	Number of transactions	Average number of acres per transaction	Price per acre
Pastureland	2	51	$752
Cropland	5	239	$975
Total	7	185 (average)	$911 (average) $986 (weighted average)

a. Type of land category reflects primary use of land.

Table B.6 summarizes the unique transactions used in the USDA WRP appraisals.

Table B.6. Summary of property transactions used in the three WRP easement appraisals in the St. Joe River area during 1994-2000

Type of land[a]	Number of unique transactions	Average number of acres per transaction	Price per acre
Pastureland	7	60	$1,206
Timberland	6	50	$1,378
Cropland	12	143	$1,357
Wetlands	1	92	$325
Total	26[b]	97 (average)	$1,281 (average) $1,191 (weighted average)

a. Type of land category reflects primary use of land.
b. The sum of the number of transactions listed in each appraisal is 39; however, several transactions appeared in more than one appraisal. In fact, there are 26 unique transactions.

B.1.3 Lower basin land price summary

Table B.7 summarizes low, average, and high dollar values for current property listings, past transactions, and easements with the USDA WRP. Figure B.3 shows the approximate location of these properties.

Table B.7. Summary of land values in St. Joe/Coeur d'Alene area

Category	Low ($/acre)	Average ($/acre)	Weighted average ($/acre)	High ($/acre)
Property listings (June 2004)	1,100	1,403	1,361	1,830
Transactions (1993 to 2001)	325	1,510	1,384	3,791
Easements with USDA WRP (1997 to 2003)	325	1,281	1,191	1,426

An average of these Table B.6 values is not developed because many of the same properties are included in the various categories. The overall recommended price for estimating the cost to purchase large parcels of land (e.g., greater than 200 acres) similar to the contaminated federal lands of the lower Coeur d'Alene River basin is in the range of $1,200 to $1,500 per acre (2004 dollars).

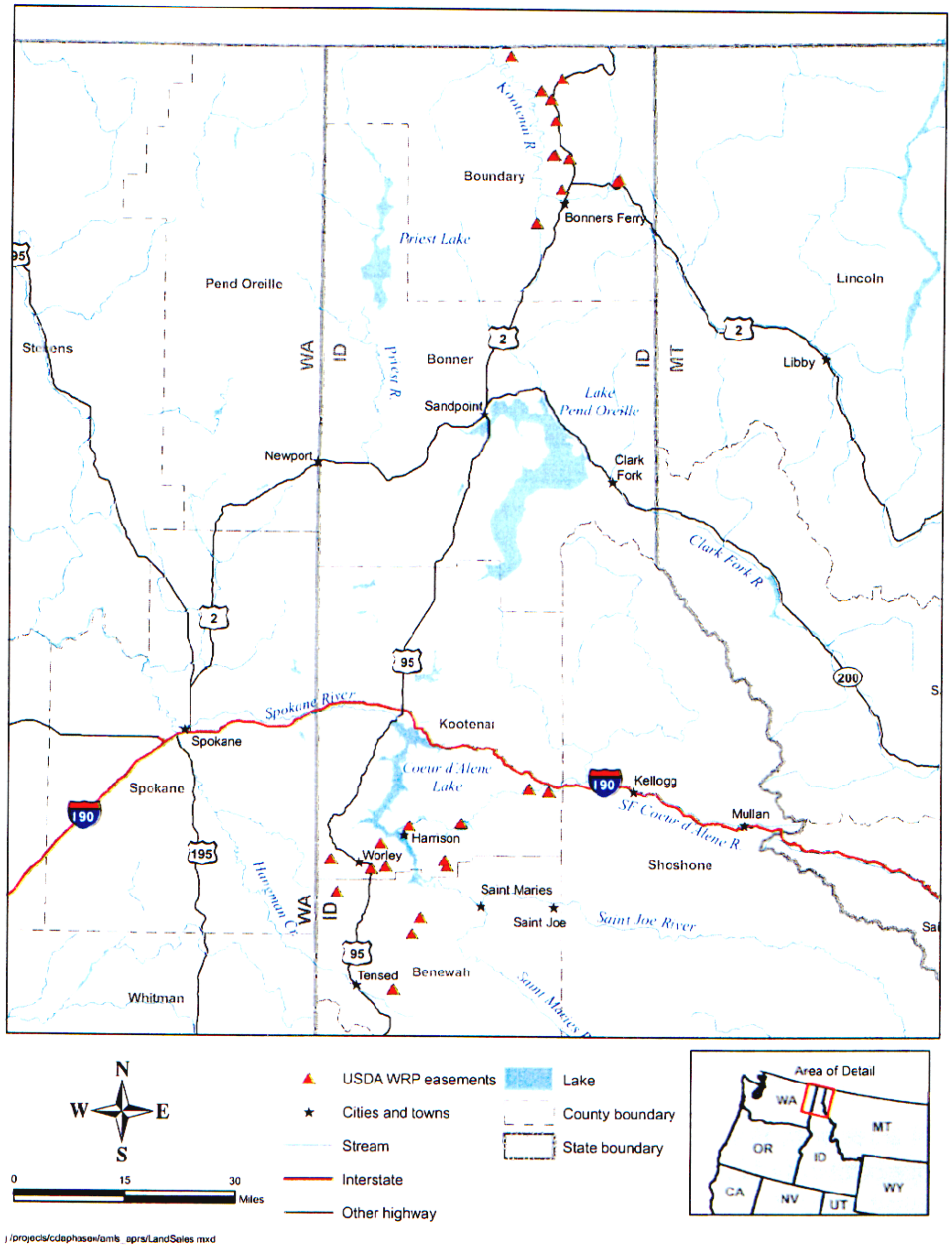

Figure B.3. Approximate locations of WRP properties.

B.2 Costs of Land Acquisition in Upper Coeur d'Alene River Basin

This section takes a similar approach as for the lower basin lands to estimate the cost of purchasing, or obtaining easements on, lands similar to the federal lands in the upper Coeur d'Alene basin but for the contamination. The federal lands of concern in the upper basin are riparian lands along and hydraulically connected to rivers and creeks. To the degree possible, we rely on recent transactions of land comparable in type to that being offset. Because there have been relatively few recent transactions, we also incorporate information about lands currently available for purchase. We have adjusted the list price of lands still for sale by reducing the offer price by 17% to approximate the same observed price reduction in purchased lands (average ratio of sold price to offer price for "sold" lands in Table B.10 is 0.83).

The relative size of lots in the upper basin region, for river frontage property with riparian habitat, tends to be smaller than in the lower basin. In addition, the main attribute of concern for acquired lands in the upper basin is the total riverfront area, to address injuries to riparian habitat. We therefore normalized the cost of identified lands by the length of riverfront access. Parcels with relatively small riverfront access are less preferred to parcels with relatively larger riverfront areas. Because price per acre is typically lower for large parcels (e.g., greater than 100 acres) when compared to small parcels (e.g., in the 2-5 acre range), we limited our dataset to parcels over 10 acres.

The priority area is defined as lands with riverfront property along the following waterways: upper Coeur d'Alene River (North Fork and South Fork), Fourth of July Creek, Douglas Creek, Wolf Lodge Creek, and Fernan Creek. To estimate costs to acquire such land, current property listings were examined, along with appraisals and previous sales transactions.

B.2.1 Available properties

The following are current parcels of land for sale in the identified area (Table B.8):

- 355 acres along the North Fork are for sale for $850,000, or $2,394 per acre. This land includes 2/5 mile of river frontage and 1/2 mile of frontage to Cougar Creek. November Creek also flows through the property (Gold Creek Properties, 2004).
- 144 acres with Fourth of July Creek running through property for sale for $399,000 (approximately $2,771 per acre) (Rocky Banks, Hope Realty, personal communication, August 5, 2004).
- 80 acres on the South Fork near Pinehurst, ID are for sale for $575,000, or $7,188 per acre (National Association of Realtors, 2004).

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Table B.8. Summary of riverfront property listings as of August 5, 2004

Location	Acres	Type of land	Price per acre	Number of waterfront feet	Price per waterfront foot
North Fork	355	Riverfront, large parcel	$2,394	North Fork: 2,112; Cougar Creek: 2,640	$180
Fourth of July Creek	144	Creekfront, mostly level	$2,771	?	
South Fork	80	Riverfront, large parcel	$7,188	?	
South Fork	500	Prime recreational riverfront, small parcel as part of larger property	$7,500	31,680	$118

- 500 acres near Cataldo/Mission area on the South Fork, including 3 miles of riverfront (634 linear feet per parcel, if equally divided). Individual 20 acre parcels are being sold for $125,000 to $175,000 (approximately $6,250 to $8,750 per acre, averaging $7,500 per acre); 200 acres are located on the south side of the river and 300 are on north side. The owner would be willing to consider selling entire parcel, price negotiable (Ed Short, North Idaho Land, personal communication, August 5, 2004). If all 500 acres sold for $7,500 per acre, the purchase price would be $3.75 million.

B.2.2 Previous transactions

The smallest Coeur d'Alene riverfront lots used for recreational homesites (1/4 acre lots) have been selling for $300 to $400 per foot of river frontage (approximately 200 feet deep), averaging $83,000 per acre (Ed Short, North Idaho Land, personal communication, August 5, 2004). Larger parcels of land have been selling for $2,000 per acre to $5,000 per acre, and have price per riverfront foot about $100 to $200 per acre (Ed Short, North Idaho Land, August 5, 2004).

The following are details concerning recent sales transactions (Table B.9):

- 103 acres along the St. Joe near St. Maries, ID, sold in October 2003, for $180,000 ($1,748 per acre).The property contains 3,960 feet of riverfront, equating to $45 per linear foot (Rocky Banks, Hope Realty, personal communication, August 5, 2004).

- 103 acres sold in September 2003, for $202,000 ($1,961 per acre). The property contains 5,280 feet of riverfront, equating to $38 per linear foot (Rocky Banks, Hope Realty, personal communication, August 5, 2004).

- 15 acres on the South Fork sold in August 2004, for $60,000 ($4,000 per acre) (Rocky Banks, Hope Realty, personal communication, August 5, 2004).

Table B.9. Summary of riverfront comparable sales transactions before August 5, 2004

Location	Acres	Type of land	Price per acre	Number of waterfront feet	Price per waterfront foot
St. Joe	103	Riverfront, large parcel	$1,748	3,960	$45
St. Joe	103	Riverfront, large parcel	$1,961	5,280	$38
South Fork	15	Riverfront, small parcel	$4,000	?	

Table B.10 and Figure B.4 show all sites included in the dataset evaluated to estimate a reasonable price per acre of lands similar to the subject lands in the upper Coeur d'Alene basin. A reasonable estimate of the cost to acquire an acre of river front land with appropriate riparian and floodplain characteristics is estimated to be approximately $5,000 per acre.

Table B.10. Summary of land transactions and prices per acre

Status	Location	Acres	Asking price	Selling price	Description	Price per acre
Sold	St. Joe	103	$210,000	$180,000	Riverfront large parcel	$1,750
Sold	St. Joe	103	$210,000	$202,000	Riverfront large parcel	$1,960
Sold	Rose Lake	142		$210,000	In 100-yr floodplain; protected by road	$1,480
Sold	South of Cave Lake	262		$280,000	Cleared pasture and cutover timber	$1,070
Sold	Latour Creek	80		$165,000	Floodplain	$2,060
Sold	South Fork	15	$60,000	$40,000	Riverfront small parcel	$2,670
On Market	South Fork	500	$3,750,000	$3,110,000	Prime rec. parcel, part of larger lot	$6,210
On Market	Marie Creek	97	$349,000	$289,000	Creek front, some level with hillside	$2,980
On Market	Old River Road	10	$399,000	$330,600	Riverfront small parcel	$33,100
On Market	Eagle Creek	10	$49,900	$41,300	Riverfront small parcel	$4,130
On Market	Eagle Creek	10	$54,900	$45,500	Riverfront small parcel	$4,590
On Market	North Fork	355	$850,000	$704,000	Riverfront large parcel	$1,990
On Market	Fourth of July Creek	144	$399,000	$330,600	Creek front, mostly level	$2,300
On Market	South Fork	80	$575,000	$476,000	Riverfront large parcel	$5,960
Average						$5,150
Maximum						$33,100
Minimum						$1,070

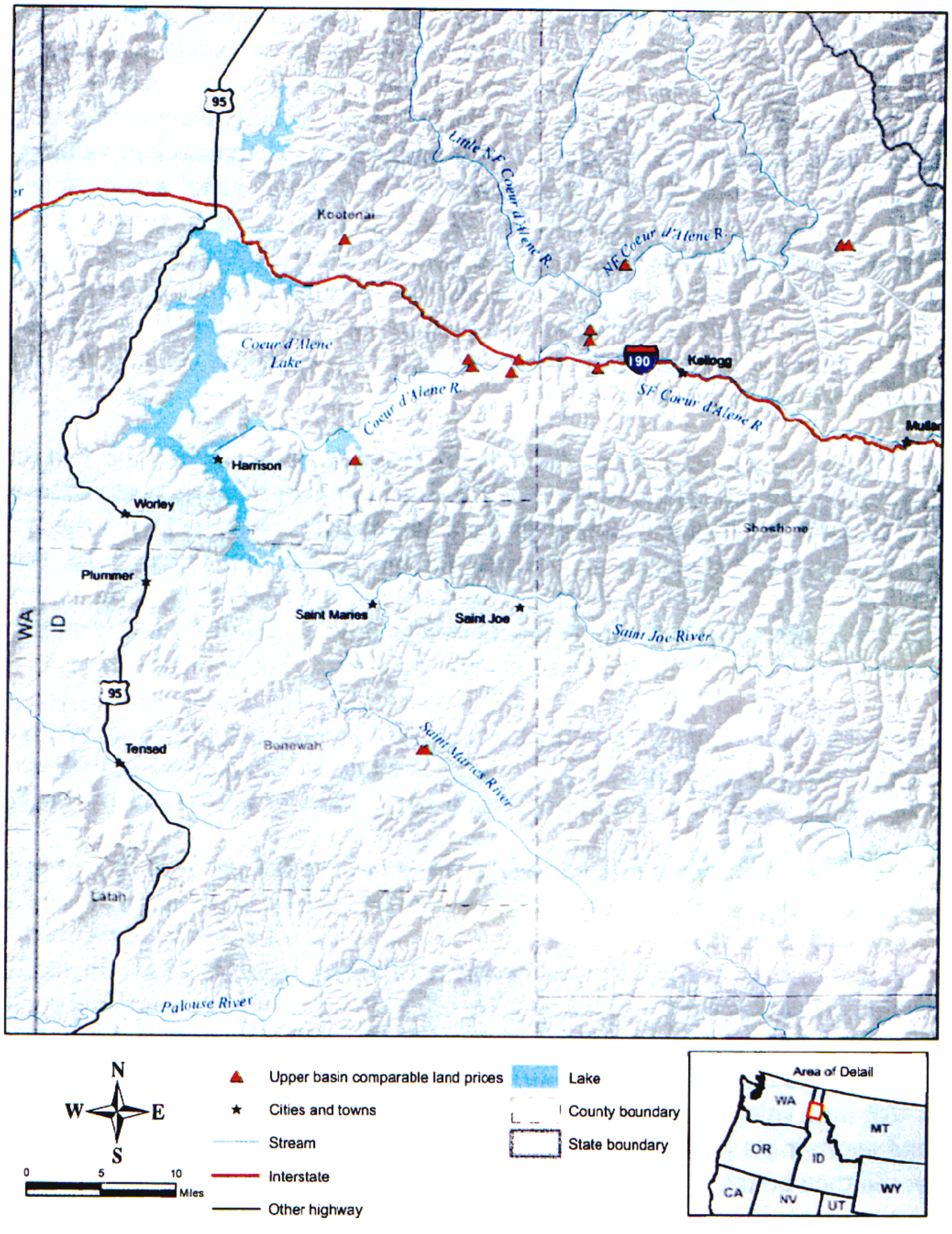

Figure B.4. Approximate locations of upper basin comparable land sites.

Conservation easements

This section discusses the cost of acquiring a conservation easements on upper basin lands as an alternative to land purchases. In some cases, a conservation easement can be a significant component to providing ecological services in the riparian floodplain zone. A conservation easement may be an appropriate alternative to the actual purchase of lands if sufficient protection of the habitats of concern can be developed. A commonly accepted approach to valuing conservation easements is through what is known as the "before and after" approach (Appraisal Institute, 1995). The first step is to establish the fair market value of the property before it is restricted. The second step is to determine the fair market value after the property is restricted. This step requires that the landowner and the easement holder agree on the terms of the conservation easement, so that the appraiser knows what rights the landowner is retaining and giving up. The difference between the "before" and "after" appraisals is considered to be the value of the conservation easement.

The upper bound of the price of a conservation easement is the total value of the area of land where an easement is put in place. The lower end estimate of the price of conservation easements in the upper Coeur d'Alene basin area depends on a number of factors, including the location of the easement, the current land use, and the degree of restrictiveness of the easement. For a conservation easement to provide similar types and degrees of ecological benefits to those lost as a result of contamination, the easement would be considered very restrictive. It is anticipated that all active human uses in the floodplain would be eliminated, including timber harvest, agricultural activities, recreational activities, and development. In addition, activities on areas adjacent to the floodplain riparian zone habitat would be limited to ensure full productivity of the riparian habitat. The exact area necessary on any given parcel would depend on the size of the adjacent stream, slope of adjacent lands, and floodplain dynamics, among other characteristics.

There have been a limited number of conservation easements in the upper basin region to use as price comparisons. Many of the easement transactions that have been put in place are done through donations of the easement by the property owner to the easement holder (Steve Gourke, The Nature Conservancy of Idaho, personal communication, August 16, 2004). In addition, the exact nature of the easements dictates the specific price, and this price can vary depending on the before and after value of the land. However, in all cases, the base valuation is dependent on the initial value of the land and then the value of the conservation easement is estimated as a reduction of that land value. As described in Section B.2.2, the estimated price per acre of riverfront land appropriate for acquisition as replacement of lost resources is about $5,000 per acre. This would then be the upper bound estimate of the total value of a very restrictive conservation easement. However, in general, the total property value is not lost through a conservation easement. While the specific nature of the easement will drive the estimated value, would not be unreasonable to expect that 50% to 80% of the property value would be lost due to a restrictive conservation easement as described above (Monty White, Idaho Department of

Lands, Land Real Estate Specialist, personal communication, August 16, 2004; Stacey Stovall, Conservation Innovations, Inc., personal communication, August 18, 2004). For purposes of estimating an approximate cost of obtaining the type of conservation easement appropriate to provide the necessary ecological services, we use 75% of the total land value, which would be 0.75 x $5,150 = $3,865.

Administrative cost of land acquisition and easements

In addition to the basic cost of the payment to the land holder to acquire property or an easement, there are significant administrative costs that an agency incurs to complete the transaction. These administrative costs include surveys or title searches, appraisals, and costs incurred in managing and enforcing the easements. The exact amount of administrative costs associated with any specific land purchase or easement will vary depending on the nature of the negotiation process, the specific property, and the entity undertaking the administrative duties. While the costs are variable, they can be significant and should always be included in the overall estimate of the total cost to acquire property or an easement. We are developing a range of administrative costs that should be added to the actual property purchase or easement cost when estimating the full cost of acquisition and easements.

Appendix C — Resumes

Katherine D. LeJeune
David J. Chapman
Greg Koonce

Katherine D. LeJeune

Employment History

- Principal, Stratus Consulting Inc., Boulder, CO; Managing Scientist, 2003-2004; Manager, 1998-2003
- Manager, Hagler Bailly, Boulder, CO, 1998; Senior Associate, 1995-1997; Associate, 1991-1995
- Research Assistant, University of Virginia, 1988-1991

Education

- University of Colorado, PhD, Ecosystem Ecology and Biogeochemistry, 2002
- University of Virginia, MS, Environmental Sciences, 1991
- University of Virginia, BA, Environmental Sciences, 1988

Professional Experience

Dr. LeJeune has 15 years of experience evaluating effects of natural and anthropogenic disturbances on ecosystems, specializing in assessment of biogeochemical interactions between water, soil, and vegetation communities. She has assessed the effects of chemical contaminants on soil nutrient cycling, vegetation composition and structure, wildlife habitat, and wildlife populations, and methods for restoring disturbed soils, surface water, and ecosystem functions. She has investigated the effects of invasive plant species on soil nutrient cycling and native plant communities, and biological, physical, and biogeochemical methods for controlling invasive plant species. Much of her work has focused on the effects of hard rock mining on surface water, soils, and vegetation. She has investigated the effects of mining at sites throughout the United States, as well as in South America.

Dr. LeJeune has 13 years of experience conducting natural resource damage assessments (NRDAs) for federal, state, and tribal trustees. She has provided expert technical assistance and direction, as well as case strategy and management services to trustees. Dr. LeJeune has also directed the identification, evaluation, and scaling of ecological restoration projects for implementation by NRDA trustees to compensate for losses of natural resources.

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LeJeune K.D. and T.R. Seastedt. 2003. Heterogeneity in cover and nutrient availability facilitates establishment of non-native plants in mixed-grass prairie. Society of Ecological Restoration International 2003 Annual Conference. Austin, TX. November 19-22.

Seastedt, T.R., K.D. LeJeune, and K.N. Suding. 2003. Effects of insect herbivores, soil nutrients, and plant competition on diffuse knapweed. Invasive Plants in Natural and Managed Systems: Linking Science and Management and 7th International Conference on the Ecology and Management of Alien Plant Invasions. November 3-8, Wyndham Bonaventure Resort, Ft. Lauderdale, FL.

LeJeune, K.D., K.N. Suding, and T.R. Seastedt. 2002. *Centaurea diffusa* (diffuse knapweed) and soil nutrient cycling in the Colorado Front Range. Annual Meeting of Ecological Society of America, Tucson, AZ.

Seastedt, T.R., D. Buckner, K.D. LeJeune, and K.N. Suding. 2002. Vegetation response to biological control of diffuse knapweed in the Colorado Front Range. Annual Meeting of Ecological Society of America, Tucson, AZ.

LeJeune, K.D., T.R. Seastedt, and K.N. Suding. 2002. Nutrient competition in a diffuse knapweed (*Centaurea diffusa*) invaded prairie, and implications for land management. Presentation to Boulder County and Boulder City Open Space, Boulder, CO. April.

LeJeune, K.D., T.R. Seastedt, and K.N. Suding. 2001. Nutrient competition in a diffuse knapweed (*Centaurea diffusa*) invaded prairie. Annual Meeting of Ecological Society of America, Madison, WI.

Invited Panelist, NGO Efforts to Protect Biodiversity. Exploring a Cartography of Governance: the Province of Environmental NGOs. University of Colorado Law School, April 2001.

LeJeune, K., A.S. Maest, and D. Cacela. 2000. Determination of baseline soil and sediment metals concentrations in the Coeur d'Alene Mining District, Idaho. Geological Society of America Annual Meeting, Reno, NV. November.

LeJeune, K., D. Cacela, D. Lane, and D. Beltman. 1996. Evaluation of site-specific soil toxicity using local and native Taxa. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Washington, DC. November.

LeJeune, K., D. Cacela, D. Lane, and J. Lipton. 1996. Ecological impacts of mine-waste contaminated alluvial soils on indigenous riparian communities. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Washington, DC.

Cacela, D., K. LeJeune, and J. Lipton. 1996. Use of multivariate statistical analysis to delineate the extent of metals contamination in a floodplain. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Washington, DC.

Galbraith, H., K. LeJeune, T. Podrabsky , and J. Lipton. 1996. Mass mortality of snow geese in southwest Montana due to mining-related contaminants. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Annual Meeting, Washington, DC.

Lipton, J., K. LeJeune, D. Cacela, H. Galbraith, and T. Podrabsky. 1995. Impacts of smelter emissions on vegetation: the identification of causal mechanisms. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, BC.

Galbraith, H., K. LeJeune, and J. Lipton. 1994. Contaminant effects on terrestrial resources: vegetation community and wildlife habitat evaluation. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Denver, CO.

Galbraith, H., J. Lipton, and K. LeJeune. 1994. Effects of mine wastes on riparian soils, vegetation, wildlife habitat. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Denver, CO.

LeJeune, K. J. Lipton and H. Galbraith. 1994. Contaminant effects on terrestrial resources: sampling design and patterns of soil contamination. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Denver, CO.

Kapustka, L., J. Lipton, and K. LeJeune. 1994. Phytotoxicity of metals and arsenic-contaminated soils. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Denver, CO.

USEXRPT000383

Expert Testimony

United States v. ASARCO Inc. et al. (Case No. CV 96-0122-N-EJL), Natural Resource Damage Assessment. For U.S. DOI and U.S. Department of Justice, deposition (1999); trial (2001).

State of Montana v. Atlantic Richfield Company (Case No. CV-83-317-HLN-PGH), Natural Resource Damage Assessment. For State of Montana, deposition (1995) and trial (1997).

Affiliations

Ecological Society of America
Society of Ecological Restoration

David J. Chapman

Employment History

- Managing Economist, Stratus Consulting Inc., Boulder, CO, 2003-present
- Chief, Pacific Coast Branch, Damage Assessment Center, NOAA, 2000-2003; Acting Chief, 1999-2000
- Economist, Damage Assessment Center, NOAA, 1993-1999
- Consultant, California Department of Fish and Game, 1992-1993
- Consultant, Foster Associates, San Francisco, CA, 1992
- Consultant, State of California Department of Fish and Game, 1990-1993
- Research Consultant, NRDA Inc., San Diego, CA, 1989-1992
- Research Consultant, Minerals Management Service/University of Washington, Department of Forestry, 1989
- Research Consultant to Dr. W. Michael Hanemann (UC Berkeley), 1985-1986
- Graduate Student Instructor, University of California Berkeley, 1985-1991

Education

- University of California, Irvine, BA, Economics, 1983
- University of California, Berkeley, MS, Natural Resource Economics, 1990 (with PhD studies)

Professional Experience

Mr. Chapman has 18 years of experience in natural resource valuation and policy analysis, specializing in behavioral and welfare effects of environmental and natural resource impacts and federal environmental policy. He is experienced in the technical development and implementation of non-market valuation studies to measure the welfare effects of environmental contamination. In addition, Mr. Chapman has coordinated the development and evaluation of federal and state environmental policies and assisted in the development of federal regulations. He has over 10 years of experience working in the federal government conducting natural resource damage assessments (NRDAs), policy evaluation, and regulation development.

At Stratus Consulting, Mr. Chapman leads NRDA projects for both state and federal clients, is leading projects on non-market valuation studies including the valuation of coral reefs and improved weather information, and has worked on the conceptual and empirical estimates of the value of water for the American Water Works Research Foundation.

As Pacific branch chief for NOAA's Damage Assessment Center, Mr. Chapman's responsibilities covered the region from Alaska to California, and the Pacific Islands. He was responsible for the overall management of all scientific and economic studies conducted in support of multiple NRDAs for oil spills and toxic waste sites. Activities included spill response coordination, case strategy, technical assessment guidance, quality assurance, and management of eight technical and administrative staff members. Activities also included the role of senior economist on NOAA research projects.

Mr. Chapman served as the lead NOAA economist on over 20 NRDAs as well as methods development and training of in-house and state and federal agency personnel on economic methods.

Mr. Chapman's experience includes the following:

- Served as expert witness to the California Department of Fish and Game on oil spill valuation, and supported the California Office of Attorney General to measure recreation losses resulting from the *American Trader* oil spill, including depositing and testifying at trial (1997).
- Served as expert consultant on the *Avila Beach* oil spill NRDA responsible for data collection on response to spill and human use of site, development of assessment research plan, implementation of assessment, and authoring expert report, and participated in settlement negotiations.
- Provided economic analysis on consultant projects dealing with industrial and commercial sector water conservation practices, and measuring economic impact of proposed Bay Area Rapid Transit extension through the City of Fremont, California.
- Developed fair market valuation study for fiber optic cable right of way through National Marine Sanctuaries.
- Supported economic damage assessment for the *Exxon Valdez* oil spill NRDA.
- Developed economic analysis to estimate the impact of oil and gas development along the Oregon and Washington coasts, including development of a contingent valuation survey.
- Supported economic impact of proposed agricultural wastewater discharges into the San Joaquin River, recreational assessment for the albacore sport fishing economic and marine recreational fishing studies.

Selected Articles/Reports

Allen, P.D., D.J. Chapman, and D. Lane. "Scaling Environmental Restoration to Offset Injury Using Habitat Equivalency Analysis." In *Integrating Ecologic Assessment of Economics to Manage Watershed Problems,* R.J.F. Bruins and M. Heberlein (eds.). CRC Press, Boca Raton, FL. Forthcoming.

Chapman, D. and B. Julius. 2004. "The Use of Preventative Projects as Compensatory Restoration." Forthcoming in *Journal of Coastal Research.*

Chapman D. and W.M. Hanemann. 2001. "Environmental Damages in Court: The *American Trader* Case." In *The Law and Economics of the Environment,* Anthony Heyes (ed.), pp. 319-367.

Chapman, D. and E. English. 2001. Fair Market Value Analysis for a Fiber Optic Cable Permit in National Marine Sanctuaries. Report to National Marine Sanctuary Program, National Oceanic and Atmospheric Administration, Silver Spring, MD.

Chapman, D., N. Iadanza, and T. Penn. 1998. *"Calculating Resource Compensation: An Application of the Service-to-Service Approach to the Blackbird Mine Hazardous Waste Site."* National Oceanic and Atmospheric Administration Damage Assessment and Restoration Program Technical Paper 97-1. October.

Chapman, D., W.M. Hanemann, and P. Ruud. 1998. *American Trader* Oil Spill: A View from the Beaches. Featured Essay in *AERE Newsletter* 18(2).

Chapman, D. and W.M. Hanemann. 1999. Non-Market Valuation Using Contingent Behavior: Model Specification and Consistency Tests. In *Proceeding of the 1996 Annual AERE Workshop,* Tahoe City, CA. June.

Kanninen, B., D. Chapman, and W.M. Hanemann. 1992. Survey Data Collection; Detecting and Correcting for Biases in Responses to Mail and Telephone Surveys. In *Proceedings of the U.S. Census Bureau's Annual Research Conference.*

Ellis, G., D. Chapman, and N. Johnson. 1991. Assessing the Economic Impact to Coastal Recreation and Tourism from Oil and Gas Development in the Oregon and Washington Outer Continental Shelf. OCS Study MMS 91-0046. May.

Hanemann, M., E. Lichtenberg, D. Zilberman, D. Chapman, L. Dixon, G. Ellis, and J. Hukkinen. 1987. Economic Implications of Regulating Agricultural Drainage to the San Joaquin River. Regulation of Agricultural Drainage to the San Joaquin River. SWRCB Order No. W.Q. 85-1,

Technical Committee Report. Appendix G (two vols.). State Water Resources Control Board, Sacramento, California.

Presentations/Short Courses/Working Papers

"The Use of Preventative Projects as Compensatory Restoration" Restore America's Estuaries Conference, Baltimore, MD. April 2003.

"Developing Defensible NRDA Claims" Short Course. International Oil Spill Conference. Vancouver, British Columbia Canada. April 2003.

"Non-Market Valuation Techniques in Natural Resource Damage Assessments." Invited Lecture Series. Department of Economics, College of William and Mary, Williamsburg, VA. Spring 2003.

"NOAA's Blue Ribbon Panel: 10 Years After" Invited Panelist. Resources for the Future, Washington, D.C. November 2002.

"Cooperative NRDA Assessments." Short course. International Oil Spill Conference, Tampa Bay. March 2001.

"The Role of Natural Resource Economics in the *American Trader* Oil Spill Trial." Invited speaker at the Yosemite Law Institute, Yosemite, CA. October 1998.

"Using Economics in the Courts" Presentation to the Southern Economic Association Meeting, Baltimore, MD. October 1998.

"Use of Habitat Equivalency Analysis in Natural Resource Damage Assessments." Presentation to the Joint Assessment Team, Portland, OR. June 1996.

"Non-Market Valuation Using Contingent Behavior: Model Specification and Consistency Tests." Presented at the 1996 Annual AERE Workshop, Tahoe City, CA. June 1996.

"Resource Compensation: An Application of Northwest Salmon" Presented at the W-133 Annual Meetings, Jekyll Island, GA. March 1996.

"Natural Resource Economics" Presented to the Natural Resource Damage Assessment and Restoration Workshop, Sponsored by USFWS. April 1994.

Chapman, D., and W.M. Hanemann. "*Correlated Discrete-Response Contingent Valuation*" Department of Agricultural and Resource Economics, Working Paper, University of California. Berkeley. July, 1993.

Hanemann, W.M., D. Chapman, and B. Kanninen. *"Non-Market Valuation Using Contingent Behavior: Model Specification and Consistency Tests."* Department of Agricultural and Resource Economics, Working Paper, University of California. Berkeley. January 1993.

"Survey Data Collection: Detecting and Correcting for Biases in Responses to Mail and Telephone Surveys." (co-authored with B. Kanninen) Presented at the United States Census Bureau's Conference on Statistical Methods, Washington D.C. March 1992.

"Empirical Uses of Contingent Valuation Studies in Natural Resource Damage Assessments." Presented to Department of Forestry, University of Washington. July 1989.

Hanemann, W.M., D. Chapman. *"Beyond Contingent Valuation: Deriving Environmental Benefits from Hypothetical Data."* Department of Agricultural and Resource Economics, Working Paper, University of California, Berkeley. October, 1988.

"Beyond Contingent Valuation: Deriving Environmental Benefits from Hypothetical Behavior Data." (co-authored with W.M. Hanemann) Presented at the American Public Policy Association Meeting, Washington, D.C. October 29, 1987.

Litigation Experience/Testimony

Montrose Superfund Site, 2000. Expert witness preparation and deposition support.

American Trader Oil Spill, 1990. Expert witness, report development, and deposition and trial testimony.

NOAA Facilitation and Mediation Training Workshop June 1998.

Advanced Quantitative Marketing Methods, Haas Business School, UC Berkeley, July 30-August 1, 1997.

Stated Preference Short Course. Portland State University. June 24-27, 1996.

Qualitative Choice Methods Workshop. UC Berkeley May 4-8, 1992.

Affiliations

- Association of Environmental and Resource Economics
- American Economic Association

Greg Koonce, CFP

As the founding partner of Inter-Fluve, Mr. Koonce has worked on land and water resource restoration projects that focus on fish habitat since 1980. Greg specializes in the development of salmonid habitat designs that function within the altered characteristics and design constraints of urbanized stream systems. He has conducted research into various life stage habitat requirements for trout, Steelhead, and Pacific salmon. He has developed strategies to remedy migratory passage problems for both adult and juvenile salmonids. Greg combines his fisheries background with several years of work in fluvial geomorphology involving studies in stream channel form and process including storm event related scour and deposition characteristics of natural channels and sediment transport dynamics. Greg frequently provides fisheries habitat and channel restoration expertise to large urban planning efforts involving aquatic resources. Greg's communication skills and knowledge of fisheries issues are commonly used to facilitate the interaction between agencies, municipalities, and citizen groups concerned with riparian areas, greenways, and stream habitats. He has served in advisory positions on several large-scale riparian restoration projects including one within a World Heritage Site in California. He has also served in a technical advisory role to Bonneville Power Administration (BPA) assisting in their efforts to develop criteria for salmonid recovery in Oregon, Washington, Idaho, and Montana.

Selected Project Experience

Cedar River Fish Passage Improvement Project – Seattle, WA. Finalized negotiations for mitigation requirements to offset habitat losses incurred as a result of upgraded water supply facilities for the City of Seattle. Managed the development of a habitat mitigation plan, oversaw the construction and implementation of habitat mitigation elements and wrote a habitat mitigation monitoring plan. Project is unique due to the accelerated time frame (final mitigation agreement to construction completion in less than a year) and the establishment of habitat improvements for use by juvenile salmonids during winter storm events.

San Antonio River Improvements – San Antonio, TX. Currently providing fisheries habitat and geomorphic review for the planned recovery of habitats within a 13-mile reach of a highly modified urban river. Habitat recovery for fish and native riparian habitats is especially challenging due to the overriding goals for flood abatement and infrastructure protection. Emphasis is placed on restoration of fundamental ecosystem processes that result from geomorphic and hydraulic processes altered through the impact of urban influences on geology and flow regime.

PRINCIPAL / FISHERIES BIOLOGIST

EXPERTISE

Fish Habitat as a product of Stream Geomorphology

Fish Biology Interactions with Fluid Dynamics

Fisheries Habitat Rehabilitation Design

Fish Population Assessments

Fish Habitat Assessments

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

Certified Fisheries Professional
American Fisheries Society

Oregon Trout

EDUCATION

Graduate level work in Watershed Management, Humboldt State University

BS, Fisheries Biology, Humboldt State University, 1980

Greg Koonce: Other Significant Projects

37 Mile Creek Channel Extension – Haines, AK. Provided design criteria for the design and subsequent monitoring of a 7,000-foot extension of the lower end of 37 Mile Creek, a tributary to the Klehini River. Greg was lead designer for the project's 20 acres of emergent wetlands. Instrumental to his design concept was the inclusion of streams within the wetlands for greater fish habitat enhancement. Criteria included habitat preferences for all species of Eastern Pacific salmon, Dolly Varden and Coastal Cutthroat including both adult and juvenile life stages. Habitat preferences were given to Coho and Chum salmon with special considerations for spawning and rearing of these fish in clear water tributaries of glacial river systems.

Fish Creek Channel and Fish Habitat Assessment – Mt. Hood National Forest, OR. Conducted flood damage assessment of fisheries habitat within an at-risk habitat for Steelhead, Coho and Chinook salmon on the Mt. Hood National Forest. Pre- and post-flood fisheries habitat typing data was statistically manipulated to determine the impact of a flood estimated to have exceeded the 100-year recurrent flow. Habitat constituents were compared with both historical air photos and post-flood longitudinal and cross-sectional surveys to develop insight into possible geomorphic-based response patterns. Management recommendations were developed to assist USFS personnel in developing restoration plans for the basin.

Storm Drainage Master Plan for Rock, Bronson, and Willow Creeks – Portland, OR. Developed stream channel restoration designs within three highly urbanized drainages of the Portland metropolitan area. Special consideration was given to habitat and biological requirements of indigenous Cutthroat trout populations, duration/frequency of discharge events, sediment management, and relative levels of urban impact.

Howard Hanson Dam Additional Water Storage Project – Tacoma, WA. Played a key role in the development of draft mitigation and restoration designs for the Green River and area tributaries following the authority of the Army Corps of Engineers and the City of Tacoma. Subsequently, served as a major author for work plans and design goals for 19 fish habitat improvement projects. Currently under a continuing contract with the Seattle District Army Corps of Engineers to assist in the development of design plans for these projects.

Rio Chimehuin and Rio Quilquihue Fish Habitat Improvements – Provincia de Neuquen, Patagonia, Argentina. Provided plans for the improvement of trout habitat on two major Argentine rivers and developed preliminary designs for the creation of three kilometers of spring creek. This project is located within the boundaries of a well-established resort catering to European and North American fly fishers.

Hardy Creek Salmon Habitat Restoration – Skamania, WA. Developed restoration designs for a significant salmonid spawning and rearing stream within a Federal Wildlife Refuge along the Columbia River. Flood flows severely damaged important spawning habitat for lower river Coho and Chum salmon and significantly impaired their movement through a concrete arch culvert. Design criteria were formulated and, with the assistance of US Fish and Wildlife personnel, developed to restore the channel to pre-flood habitat conditions and to facilitate the movement of all life stages through the culvert. Construction was conducted with Federal refuge workers and equipment. In-stream channel work was completed in the late summer of 1996 with successful Coho and Chum spawning observed in both the fall of 1996 and 1997. Juvenile migrations continue to be a monitored annually by the refuge personnel.

Greg Koonce: Other Significant Projects, continued

Picnic Point Creek Flood Damage Repair and Channel Enhancement – Snohomish County, WA. Developed fish passage and rearing habitat criteria for a flood damaged stream in suburban Everett. The wet winter of 1996 caused a portion of a county highway to fail and slide into a significant Steelhead, Coho and Chum salmon spawning stream. Emergency road crews were mobilized to repair the highway and mitigate for the in-stream damages. The habitat enhancement and channel repair designs were developed within an extremely aggressive schedule, and supervision was provided by Inter-Fluve throughout all in-stream construction activities.

Nooksack River Monitoring Plan – Bellingham, Washington. Assisted in the development of a monitoring strategy for a large-scale riverbank protection project on the Nooksack River in North-western Washington. This project involved every major species of anadromous salmonid in the Northeastern Pacific and some non-migratory species as well. A fisheries habitat monitoring method based on life-stage preferences and measurements and supplemented with visual estimates of physical conditions was developed for rapid assessment of habitat. The method places emphasis on measurements during specific hydrologic/hydraulic conditions of various seasonal uses by adults and juveniles.

Sucker Creek Mitigation, WA. Assisted in the development of a mitigation strategy for the loss of three miles of anadromous fishery stream and 10 acres of emergent wetland during the construction of a regional landfill in western Washington. Developed design plans for three miles of relocated stream, three off channel rearing ponds for Cutthroat trout and Coho salmon, and assisted with designs for 10 acres of emergent wetland. Provided construction oversight for construction of the mitigation measures.

Cove East/Upper Truckee River & Wetland Restoration Project, CA. Assisted with the development of several conceptual level river restoration designs for a degraded river system at Lake Tahoe. A fundamental goal of this project was to restore water quality and ecological function to the river, its surrounding floodplain and attendant wetlands. Dominant discharge parameters were refined and applied to the topography of the project site in a manner that maintained slope, continuity of discharge, sediment transport capacity and sediment transport competence. Each design concept was evaluated and ranked according to the following criteria: short-term maintenance, design effort and cost, permitting, water quality impacts, flooding impacts, long-term maintenance, construction difficulty, channel stability, biological resources, and water quality benefits.

Greg Koonce: Publications/Workshops

Koonce, G. P., 2003. Invited Panel Member, USFS Fish Passage Workshop. Vancouver, Washington.

Koonce, G. P., 2002. A Discussion on Stream Restoration/Enhancement Design Approaches and the Need for Standards. Columbia River Basin Conference. Spokane, Washington.

Koonce, G. P., 2001. Bioengineering Techniques and Design Criteria for the Repair of Stream Bank Failures. Workshop for Oregon Department of Transportation. Salem, Oregon.

Koonce, G. P., 2001. Applications of Bioengineering Techniques for Improving Stability of Stream Banks. Workshop for City of Eugene Department of Public Works. Eugene, Oregon.

Koonce, G.P., 2000. Applications of Fluvial Geomorphology in Stream Habitat Restoration Design. USDA Region 6 Stream and Watershed Restoration Design and Implementation Workshop. USDA Forest Service, Pendleton, OR.

Greg Koonce: Publications/Workshops, continued

Koonce, G.P., 2000. Reconstruction of a Flood Impacted Stream on the Pierce Wildlife Refuge. Wolftree, Stream and Watershed Restoration Workshop. Stevenson WA.

Koonce, G. P., 1999. Bioengineering Techniques and Design Criteria for Stabilization of Major River Bank Failures. Workshop for Portland Development Commission. Portland, OR.

Koonce, G. P., 1999. Re-Constructing Wetland Habitats, Issues and Thoughts. Lecture at the monthly meeting of the Columbia Gorge Chapter of the Oregon Native Plants Society.

Koonce, G. P., 1998. Aquatic Resource Enhancement: An Approach to the Design, Construction and Rehabilitation of Streams. Workshop for the Allied Architectural and Arts School. University of Oregon, Eugene, OR.

Koonce, G. P., 1998. Stream Condition and Rehabilitation Efforts. Sediment Workshop. Oregon Department of Environmental Quality. Portland, OR.

Koonce, G. P., 1998. Streams and Watersheds, Establishing Design Criteria for Rehabilitation. Workshop for Development of Integrated Streambank Protection Guidelines. Washington Department of Fish and Wildlife, Washington Department of Ecology. Ellensburg, WA.

Koonce, G. P., 1998. Impact of Glacial and Anthropogenic Sediments on Fish and Their Habitat. Hood River Watershed Meeting. Hood River, OR.

Mayer-Reed, C. and G. Koonce, 1998. Concepts and Technology of the A-mazing Water Garden. Annual Meeting of the American Society of Landscape Architects. Portland, OR.

Koonce, G. P., 1998. Multi-disciplinary Science and its Application in Riparian Rehabilitation. Lecture. Mt. Hood Community College. Gresham, OR.

Koonce, G. P., 1998. Stream Channel Boundary Protection; Appropriate Levels for Urban and Natural Systems. Lecture for the School of Allied Architectural and Arts. University of Oregon, Eugene, OR.

Koonce, G. P., 1997. Using Bioengineering Methods to Repair Stream Bank Failures. Workshop for Development of Integrated Streambank Protection Guidelines. Washington Department of Fish and Wildlife. Vancouver, WA.

Koonce, G.P., 1997. Applications of Fluvial Geomorphology in Stream Habitat Restoration Design. USDA Region 6 Stream and Watershed Restoration Design and Implementation Workshop. USDA Forest Service, Trout Lake, WA.

Koonce, G.P., 1997. Using Trout Habitat Assessment Data for Restoration of Stream Habitat. Design of Natural Stream Channels. Inter-Fluve, Inc. Bozeman, MT.

Koonce, G.P., 1997. Concept and Approach to Biotechnical Stream Channel Restoration Techniques. Integrated Bank Protection Seminar, Washington Department of Fish and Wildlife, Region 5, Vancouver, WA.

Koonce, G.P. 1997. Strategies for Fish Habitat Restoration Following Large Magnitude Flood Events. Mt. Hood National Forest Flood Symposium. USFS, Sandy, OR.

Greg Koonce: Publications/Workshops, continued

Koonce, G.P. 1996. Applications of Fluvial Geomorphology in Stream Habitat Restoration Design. USDA Region 6 Workshop on Stream Channel Restoration. USDA Forest Service, Cascade Locks, OR.

Koonce, G.P. 1996. Using Trout Habitat Assessment Data for Restoration of Stream Habitat. Applied Fluvial Geomorphology in Stream Habitat Design and Restoration. Wetlands Training Institute. Bozeman, MT.

Koonce, G.P. 1996. Effects and Implications of Urban Hydrology on Stream Habitat. Integrating Stormwater into the Urban Fabric. Annual Meeting of the Oregon Chapter of the American Society of Landscape Architects. Portland, OR.

Koonce, G.P. 1995. Applications of Fluvial Geomorphology in Stream Restoration Design. A Workshop on Stream Channel Restoration. USFS, Trout Lake, WA.

Koonce, G.P. 1995. Analog Method for in-Channel Restoration. Stream Restoration Conference. British Columbia Ministry of Fisheries, Squamish, Canada.

Challanger, G.E., J. Baumert, S. R. Haak, and G. P. Koonce. 1994. Mitigation for Aquatic Resource Losses: Creation of Diversion Stream Channels, Wetlands and Off-Channel Ponds. Society of Wetland Scientists, 15th Annual Meeting. Portland, OR.

Koonce, G.P. 1993. Trout Spawning Habitat Mitigation: A Constructed Example. American Society of Civil Engineers. Conference on Water Resource Planning and Management. Seattle, WA.

Koonce, G.P. 1993. BioEngineered Solutions for Streambank Erosion. Proceedings of the American Society of Landscape Architects Annual Meeting. Chicago, IL.

Koonce, G.P. 1992. Urban Stream Erosion Control Methods. Symposium on Design of Storm Water Quality Management Practices. University of Wisconsin-Madison Department of Engineering Professional Development. Portland, OR.

Koonce, G.P. 1992. Training Session on Applying Basic Hydraulic Information to design of Trout Habitat Restoration Projects. American Fisheries Society Annual Meeting. Bozeman, MT.

Koonce, G.P. 1991. Using Basic Hydraulic Analysis for In-Channel Design. In: California Salmonid Stream Habitat Restoration Manual. CDF&G Inland Fisheries Division. Sacramento, CA.

Koonce, G.P. 1991. Urban Riparian Management. Symposium on Urban Riparian Issues. Utah State University. Logan, UT.

Koonce, G.P. 1990. Two-Pin Method for Design of Stream Habitat Enhancement. Proc. of the Humboldt Chapter of the Amer. Fish. Soc. Eureka, CA.

Gebhardt, K. A., and G. P. Koonce, et al, 1988. Creating Wildlife and Wetland Amenities in an Urban Environment. Symp. Proc. of the Rocky Mt. Chap. of the Soc. of Wetland Sci. Denver, CO.

Koonce, G.P. 1984. Channel Bedform Manipulation; An Alternative to Traditional Structure Oriented Stream Enhancement Methods. Proc. of the Colo-Wyo Chapter. of the Amer. Fish. Soc. Fort Collins, CO.

Greg Koonce: Awards

Educational Achievement Award for Instruction in Designing Stormwater Quality Management Practices, University of Wisconsin-Madison College of Engineering. 1992

Additional Education

40 – Hour OSHA Hazardous Waste Operations Training, 2003